January, 1904

Instruction Pamphlet No. T 5000

INSTRUCTION PAMPHLETS

OF THE

WESTINGHOUSE TRACTION BRAKE COMPANY

New York, U. S. A., 1904

INDEX
to
Instruction Pamphlets.

PREFACE.

The recent rapid developments in the electric railway field are daily extending the use of heavy modern cars, operating at high speeds, and are raising electric railway practice to steam railway standards. With this development the use of power brakes on electric cars is rapidly becoming the universal practice. The Westinghouse Traction Brake Company has long felt the need of a manual of instruction dealing with the air brakes furnished by them, and it is with the hope that these pamphlets may prove of assistance and value to their patrons that they now offer them to the public.

They are designed to furnish information relative to the construction, operation and maintenance of Westinghouse air brakes as adapted to electric railway service, and the aim has been to adapt them to the conditions existing in this field of railroading in such a way that they may be an aid, not only to the managing and operating officials, but also to the men under them who have more immediate charge of installing, operating and maintaining the brake apparatus.

It is our purpose to issue subsequent editions of these pamphlets in the hope that, by growth and development, they may become permanent publications of value, and with the coöperation of those interested in electric railway practice we hope to have them find a place in the engineering literature dealing with subjects of this nature. With this end in view, we invite criticism and suggestion from all electric railway men, in order that shortcomings in them may be remedied, and that we may embody in later editions such further data as may generally be considered essential in treatises of this kind.

On the request of heads of departments, we shall take pleasure in supplying any reasonable number of copies of these pamphlets to electric railways having our equipments in service. Copies will also be sent on request to operating or executive officials of other electric roads.

WESTINGHOUSE TRACTION BRAKE COMPANY,
THE WESTINGHOUSE AIR BRAKE COMPANY.

26 Cortlandt Street,
New York City,
January 15th, 1904.

P. F. No. 003.

January, 1904

Instruction Pamphlet No. T 5001

The Straight-Air Brake Equipment with Motor-Driven Compressor

WESTINGHOUSE TRACTION BRAKE CO.,

26 Cortlandt Street,

New York, U. S. A.

The Westinghouse Straight-Air Traction Brake with Motor-Driven Compressor.

General Description.

This equipment is comprised of the following parts:

First—An Air Compressor actuated by an independent electric motor, which supplies the compressed air.

Second—A Compressor Governor which automatically controls the operation of the compressor, thereby maintaining the pressure and regulating the supply of compressed air.

Third—A system of wiring, including Switches and Fuse Box, which connects the main trolley circuit to the compressor and governor.

Fourth—A Reservoir in which the compressed air is stored.

Fifth—A Brake Cylinder, the piston rod of which is connected to the brake levers in such a manner that, when the piston is forced outward by air pressure, the brakes are applied.

Sixth—An Operating Valve mounted at each controlling point of the car, by means of which the compressed air is admitted to or released from the brake cylinder.

Seventh—A system of Piping, which, with various small fittings, forms the connections between the above mentioned parts, and when trailers are used includes flexible hose and couplings between cars.

Eighth—A Safety Valve placed in the air supply system to prevent any possibility of accumulating an excessive pressure.

Ninth—Also often specified is a Chime-Whistle Set, operated by air pressure, as a warning of approach, in place of a gong or bell.

Fig. 1 shows the usual arrangement of the apparatus and piping upon a double truck electric car, while Fig. 2 diagrammatically illustrates the essential parts of the brake system and their relation when applied to a motor car and trailer.

The application of the brakes by admission of compressed air from the reservoir to the brake cylinder is effected by opening either the small or the large port in the operating valve, thereby causing the piston in the cylinder to move outwardly, applying the brakes with a greater or less degree of force, depending upon which port is used, and the length of time it remains open. In an ordinary service stop the small port is opened, which allows air to flow gradually from the reservoir into the brake cylinder; but in an emergency stop the large port is employed, allowing a large amount of air to flow almost instantly into the brake cylinder. Thus the motorman is able to apply the brakes with such pressure, up to the maximum, and in as small a space of time as is desired. After admitting air to the cylinder, if the handle is placed in the position where all ports are closed, the air already admitted to the brake cylinder is retained there, thus holding the brakes applied. A further movement of the handle to the release position connects the brake cylinder with the atmosphere, permitting the air to escape, and thereby releasing the brakes. A graduated release of the brake may be obtained by permitting a portion of the air in the cylinder to escape and then returning the handle to the position where all ports are closed.

Installation of Motor-Driven Compressor Straight-Air Brake Equipment.

Fig. 2 shows the relative arrangement of the various pieces of apparatus which comprise our Motor-Driven Compressor Straight-Air Brake Equipment. This is the result of careful study and long experience, and we earnestly recommend that the parts of this equipment be connected in the same relative order as shown in the cut. In figuring out the best possible locations for the compressor, brake cylinder, and reservoir, due regard must be had to the electrical apparatus already under the car, or to be placed there, as well as to the fact that those parts requiring inspection and care should be placed in the most accessible locations to facilitate inspection and maintenance.

After these locations have been settled upon, we recommend that the apparatus be installed according to the instructions given in the Instruction Pamphlets mentioned on page 9 of this pamphlet.

Instructions for Operating the Straight-Air Brake.

As the operating valve has notches which mark the position of the handle for the various positions of the valve, it is very easy for one to operate the brake with certainty the first time, but smooth, quick and accurate stops are only made after a little practice. The operating valve handle must always be inserted at the lap position where the slot in the body is enlarged for that purpose, and withdrawn at the same point when changing from one end of the car to the other. When the handle is in lap position, as indicated by the deep notch, the valve is so placed that air can neither pass into nor out of the brake cylinder. Moving the handle of the O. V. J. valve to the end of the slot toward the left places the valve in full release, while a movement to the right, as far as the small notch, opens the small port, and a further movement to the right end of the slot opens wide the large port. A good deal of compressed air will flow through a small opening in a short time, consequently to make a light application of the brakes, move the handle to the small notch, and then quickly back to the deep notch or lap; thus the air that has been admitted to the cylinder is retained there, holding the brakes applied. To partially release the brake reduce the pressure in the cylinder by turning the handle to the release position at the left end of the slot, and almost immediately returning it to lap, thus allowing a portion of the air to escape from the cylinder.

The quickest stop obtainable is made by applying to the wheels, throughout the stop, the greatest pressure possible without causing them to slide on the rails,

and the higher the speed the greater the pressure that may be applied without danger of sliding. Thus it is evident that in order to make a quick stop, full pressure should be applied at once and gradually released as the speed falls; this method will also give a smooth stop, as the rapid reduction of speed at the end of the stop, which throws passengers, is avoided. Therefore, in making a service stop, admit twenty-five or thirty pounds of air pressure to the brake cylinder quickly at the beginning of the stop by partially opening the large port, and release it little by little as the speed drops, retaining about ten pounds in the cylinder till the car stops. A little experience will show the distance required in which to make a stop from a given speed so that all stops will be made quickly, smoothly and with but one application of the brake. A succession of applications and releases while making a stop imparts a very disagreeable motion to the car, is most wasteful of compressed air, and is reprehensible in every respect. For the emergency stop admit full pressure (about sixty pounds) immediately, without even waiting till the controller is turned off, then apply sand and release a little of the pressure as the speed drops.

Upon receiving the signal to go ahead, turn the handle to the release position before turning on the electric power. When descending a grade a beginner generally makes the mistake of putting the brake on too hard at the start; it cannot be expected that the instant the brake is applied the car will take the speed desired; make an easy application at first, hold the handle at "Lap" and give the car time to feel the effect of the brake, then if the speed is still too high, let in a *little* more air; repeat the operation as often as necessary until off the grade, in case it is a long one.

When leaving a car, always set up the hand brake, as some one might tamper with the cut-out cocks. Before starting from the car barn, be sure all cocks are properly set and that there is a good supply of air in the reservoir. Insert the handle in its socket in the operating valve and throw it around to emergency, then back to release, to see that it works freely. Try the air brake both in "service" and "emergency" to make sure that it has not been left improperly connected, etc. After this trial, and as long as proper pressure is maintained, the brake may be relied upon to perform its duty.

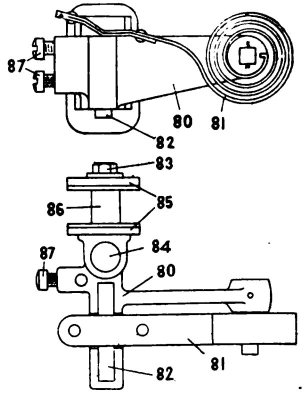
TRAILERS—Care must be taken in making up trains, that all hose couplings are thoroughly united so that the air will apply throughout the entire train. All the cut-out cocks must be opened, except those on the rear of the last car and on the front of the motor car, which must be closed. In uncoupling the cars close the cocks and disconnect the hose before pulling the draw-bar pin.

The air brake is essentially a labor saving device for the motorman, and it is scarcely necessary to ask for his coöperation in the use and care of it. Its success and general adoption for fast and heavy street railway service depends very much on his interesting himself in its use, and having an intelligent understanding of the functions of the various parts, that he may readily notice when anything about them is not working properly, and report the trouble before it becomes serious. Like the other apparatus of a street car, the air brake will not operate indefinitely without attention, and the old proverb of "a stitch in time saves nine" applies in this case as in all others.

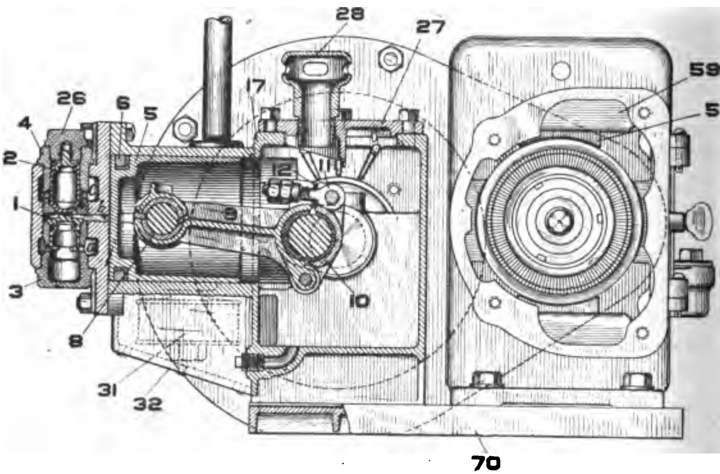
The following Instruction Pamphlets, added to this one, go to make up a complete set as applied to the Automatic Brake Equipment with Motor-Driven Compressor:

Motor-Driven Compressor	No. T 5002
Motor-Compressor Governor, Form E	T 5003
Wiring	T 5004
Reservoirs	T 5005
Brake Cylinder	T 5006
Operating Valves	T 5007
Piping	T 5008
Chime Whistle Set	T 5009

FIGURE 1.



Brush Holder.



MOTOR DRIVEN COMPRESSOR.
Type D.

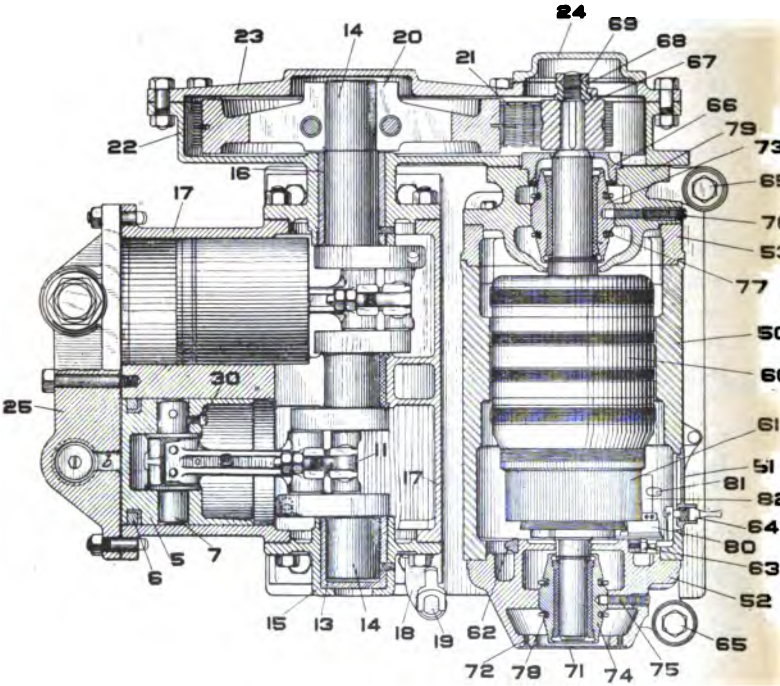
Motor-Driven Air Compressors, Type D.

Figs. 1 and 2 show the construction of this type of compressor. The air is drawn through the suction screen 31 beneath the cylinder, into the chamber *a*, thence past the two steel suction valves 1 through the ports *b*, into the cylinders. On the return stroke the air is forced back through the ports *b*, past the discharge valves 2 into the chamber *c*, from which it passes to the discharge pipe through the outlet on the upper side of and between the cylinders. Both the suction and discharge valves operate in bronze cages 3 and 4, which are removable; as the valve seats are formed on these cages, they can readily be repaired or replaced. It will be noticed that as the valves close by gravity, there are no springs to become foul or lose their temper.

The pistons, 5, are fitted with rings 6, which have been accurately ground; when taking a pump apart, to obtain the best result upon reassembling, the rings should be kept with the piston to which they were originally fitted. The wrist pins, 7, are of steel, hardened, ground, and secured in place by a set screw, 30; a bronze bushing 8 in the connecting rod 9 works on them. The crank end of the connecting rod is lined with genuine U. S. babbitt, and has a strap 10, hinged at its lower end, and secured by an eye-bolt 11 at the upper end. On this bolt between the two parts are thin steel washers 12, which may be removed as the bearing wears, and the strap then tightened down on the remaining ones and locked with the jam nut.

The center line of the cylinder is a little above the

FIGURE 2.



MOTOR DRIVEN COMPRESSOR.
Type D.

center line of the crank shaft so that the angularity of the connecting rod may be reduced during the period of compression, thereby reducing the vertical component of the thrust and consequently the wear on the cylinders. *The shaft must, however, always run with the compression part of the stroke on the upper half revolution, i. e., clockwise when viewed from the gear end.* The crank shaft 14 is made of heavy forged steel, and besides having ample end bearings 13 and 16 of bronze, is provided with a large babbitt lined center bearing, which is a part of the crank case cylinder casting 17. Crank shaft breakages are thus rendered almost an impossibility.

The above parts are all lubricated from a bath of oil which is poured into the dust proof housing through the special fitting 18, that acts as a gauge of the oil level; the fitting is closed with a suitable screw plug 19 that is secured to the crank case by means of a chain. On the overhanging end of the crank shaft is keyed and clamped a split-hub, solid sprocket-wheel 20, which is driven by a Morse silent-running, frictionless chain 21. * This chain is of unique construction in that there is none of the objectionable sliding friction to wear the joints, but only pure rolling friction on hardened steel surfaces of ample area to stand the pressure. Furthermore the sprocket teeth are so shaped that the chain will automatically assume its proper pitch diameter by climbing higher and higher on the tooth as the chain lengthens until the top of the tooth is reached. A chain, therefore, may be run until, owing to increase in pitch length, it mounts to the top and slips over the teeth of the driven wheel. When

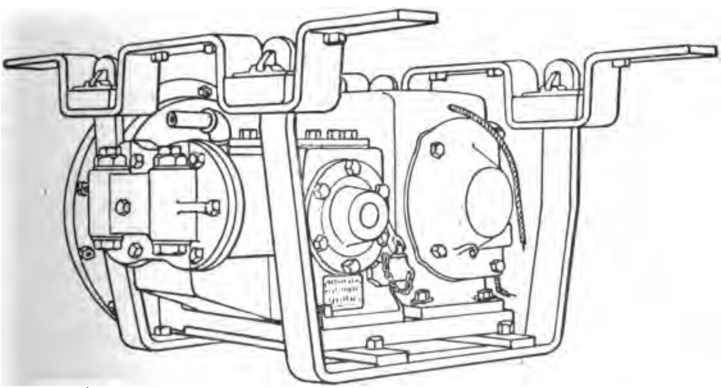
*We also furnish these compressors with motor and pump shafts connected by standard spur gears instead of the Morse chain, in all cases where same are specified.

a chain has worn thus the shortening of it by removing a link will be of no avail.

The **Motor** is of the series type with an unsplit, cast-steel-magnet frame 50, having a prolongation on the commutator end, provided with an opening to permit of ready access to the brushes and commutator. This opening has a tight-fitting door 51, hinged to the frame, which excludes rain and dust. In the ends of the frame are centered heads, 52, 53 and 79, which carry the armature bearing at the ends of the motor; 52 and 79 are provided with an oil well with filling hole so located that it is impossible to flood the interior of the motor with oil. Bronze bearing shells 73 and 74, of ample proportions, with babbitt insets, are centered in the heads and secured by means of set screws 75 and 76. Each bearing has two oil rings, 77 and 78, which insure the proper lubrication of the shaft as long as any oil remains in the wells. An overflow passage, five-eighths of an inch below the opening into the motor at the pinion end, and leading to the bottom of the gear case, effectively prevents any of the chain-lubricating oil, which might work through the pinion bearing into its oil well, from flooding the motor.

Two of the four field poles are a part of the frame 50, the other two, 58, being made up of laminations of soft iron riveted together and bolted to the frame, thereby securing in place the field coils 59, also. These are insulated and protected from moisture in accordance with standard Westinghouse railway practice, which has also been followed in all other details of electrical construction. The armature 60 is built up of soft sheet-iron punchings with accurately spaced slots in which are imbedded form-wound coils of uniform size. The commutator 61 is of

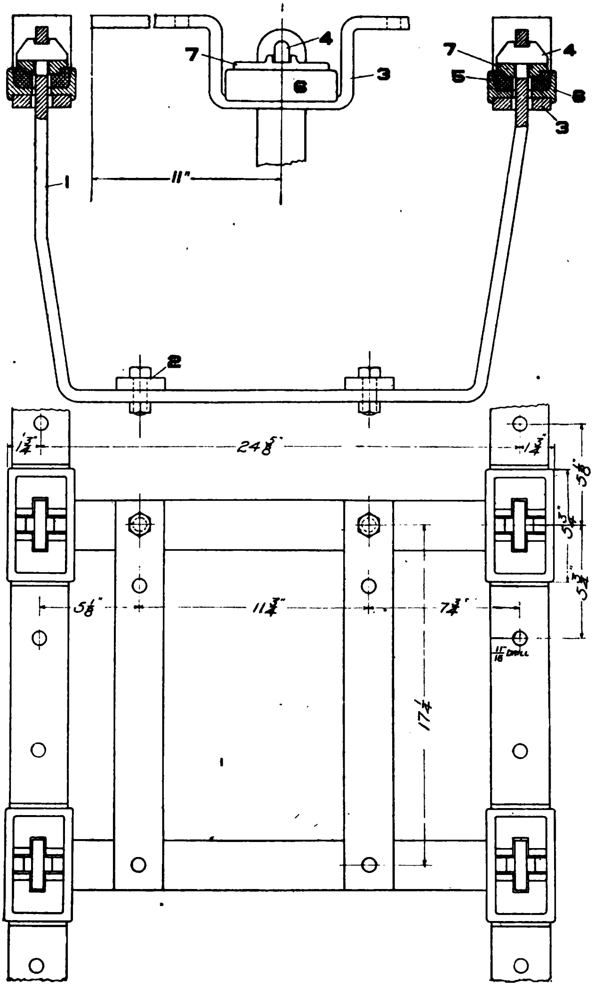
liberal length, with deep segments insulated with the best grade of mica. Special care is taken in supporting the leads from coil to segment to prevent possibility of damaging same. The two brush holders 80, (Fig. 1), mounted on the adjustable cast-iron yoke 62, are of cast bronze, with two tap bolts 83, threaded into a steel plug 84 in the holder, to secure them in position, and insulated from the yoke by hard rubber washers 85 and tubes 86, so that ample insulation has been provided at this important point. The carbon brushes 82 slide in machined ways and are held in contact with the commutator by a coiled spring 81 of bronze ribbon, thus giving a uniform tension during the life of the brush. The screws 87 are binding screws to secure the connectors firmly to the brush holder. This device has long been in use on Westinghouse motors, and has given perfect satisfaction.



SUSPENSION CRADLE.

Our standard equipment does not include a box enclosing the compressor, since the dust and rain proof

FIGURE 3.



SUSPENSION CRADLE.

construction of the D-type of compressor renders such a device superfluous and objectionable, a free circulation of air around the compressor cylinders being very desirable. With each compressor we furnish a suspension cradle, illustrated in Fig. 3, which combines compactness with great stability and affords ready access to all bolts and parts of the compressor requiring attention when in position under the car.

This device consists of two parts, the cradle 1 and 2, which is bolted to the base of the compressor, and thereby becomes an integral part of it, and the brackets 3, by which the above are secured to the car. The two brackets have two pockets each containing a rubber cushion 5, fitted in an iron casing 6, with a suitable cover 7, and these parts are provided with a slot through which the ends of the cradle may pass. These ends also have slots for notched keys 4, which latter, when in place, support the cradle with its compressor, and cannot work out. Thus the compressor is firmly supported on rubber cushions which prevent the vibrations from being transmitted to the car body, and at the same time, by raising the compressor one-half inch and slipping out four keys, the outfit may be removed from the car most readily.

We also supply with each motor compressor a set of double end wrenches specially designed to fit the various nuts and bolts, so that there may be no excuse for battering up the latter with worn out and inconvenient monkey wrenches.

Installation of the Motor-Driven Compressor.

Secure the cradle to the base of the compressor and be sure to set the cap screws and nuts up solidly, locking the same with the spring washers; then fasten the brackets solidly to the car framing at the proper distance apart, utilizing, if practicable, an existing timber for one of them, and putting in a suitable piece for the other. Use four $\frac{5}{8}''$ bolts for each bracket. Do not use lag screws unless absolutely necessary. If desirable the ends of the brackets may be bent up and bolted to the side of the sill. Place the boxes containing the rubber cushions in the hanger pockets and raise the compressor until the ends of the cradle pass through the cushions far enough for the keys to be put in; then lower the compressor until the cradle ends are seated in the notches of the keys.

The $1\frac{1}{4}$-inch pipe-tapped hole in the top of the crank case is a vent for any vapors that may be formed therein. We furnish either a vent fitting (28, Fig. 1), or pipe and fittings to carry the vapors to a point below the compressor, and in either case they should always be placed and this opening never allowed to be closed or made smaller.

If the car runs in a very dusty locality, where it is found very difficult to keep the suction screen clean or the filtering material from choking rapidly, these should be removed, the cylindrical screen taken out and the suction piped to a point inside the cab near the roof. This pipe should be as free from bends and as large as possible, certainly not less than $1\frac{1}{4}''$ for the smallest compressor. Screw the cylindrical screen on its upper end.

If this method is impracticable the following is recommended:

Bore through the sill nearest the pump a hole of such a diameter that a threaded nipple will drive through same tightly, this hole to be so located and the nipple of a suitable length, that when it is in place, the suction fitting may be screwed into a socket coupling on one projecting end and a pipe nut set up against the other side of the sill, thus securing both nipple and suction fitting rigidly in place. The free end of the nipple should then be piped to the suction orifice of the pump. Three sides of a box of the same depth as the sill, and about 12″ square, should be nailed to the latter and to the car flooring and covered on its lower surface with two or three thicknesses of cheese cloth tacked to the edges in such a manner that the suction fitting will be inside of the compartment thus formed. This arrangement will amply supply the suction with free air and should be impervious to dust, but it must be located where mud will not be thrown on to it from the wheels.

The ¾″ discharge orifice in the top of the compressor must be connected by ¾″ pipe to the reservoir, with the flexible connection of rubber hose placed in the pipe a short distance from the compressor. This hose should be located vertically so as to prevent oil gathering in it and deterioriating the rubber, and the pipe between it and the compressor should be so short as to require no supporting clamps. This whole pipe connection must lead as directly as possible from the compressor to the reservoir and have in it no branches, cocks, valves or bends which will act as pockets. *All* other connections to

the reservoir must be made at the end opposite to that at which the discharge from the pump enters, so that the air will pass through the reservoir, and deposit whatever oil, moisture or dirt that may have been entrained by it.

When looking at the motor compressor from the sprocket or gear end, the shafts of both pump and motor should rotate clock-wise, when *chain driven;* in *gear driven* forms, the pump shaft should rotate clock-wise and the motor shaft in the opposite direction. To change the direction of rotation of the armature reverse the brush-holder connection.

Inspection and Maintenance.

Cleaning and Repairing the Motor-Driven Compressor.

The caretaker should remove once a week regularly the oil plugs 19 and 65 of the compressor, Fig. 2, and replenish the oil supply, these three points being the only ones to require this attention. Use for this purpose a good quality of engine oil that will stand the high temperature obtained in the crank case when the pump is run too long continuously. We can furnish a purified West Virginia crude oil which we guarantee will give good results. It is not safe to use the ordinary West Virginia crude oil that is found unpurified in the market, as its impurities will cut the cylinders, or it will not stand the high temperature without becoming too thin and bodyless. With the chain driven pump it is usually unnecessary to put oil in the well at the pinion

end of the armature after the first installation of the apparatus is made, as thereafter its level is generally maintained by the pumping action of the chain. The commutator should be kept clean, the brushes free in their holders, and the door tightly closed that dust may not penetrate to the interior of the motor; occasionally blow the carbon dust out of the motor to avoid possibility of short circuits.

The armature bearings of bronze with genuine Babbitt metal insets should run two or three years before there is danger of the armature touching the pole pieces. As the length of time that a compressor has been in continuous service approaches the above, it should be examined at more frequent intervals, that the armature may not be permitted to get down on the field and damage or perhaps even destroy the winding.

To remove an armature first take out the four cap screws which secure the head at the commutator end of the motor, and, after disconnecting the brush holder leads and removing the brushes, withdraw the head. Now take out the three screws which secure the cap 24, Fig. 1, on gear case; insert a bolt between the upper chain and adjoining tooth of pinion, and remove lock nut 69 from end of armature shaft, using the special box wrench provided for this purpose. Then unscrew the next nut 68, which at same time pulls off the pinion; as the chain cannot move outwardly on account of the gear case cover, it is necessary that the armature should be free to move in the opposite direction. Having placed something in the bight of the chain to keep it up within reach, take out nut bolt and pinion, taking care that they do not fall into the gear case. The

armature may now be withdrawn from the motor, care being taken to prevent it from dropping on the pole pieces and thereby damaging the cross connections at the end of the core.

To put in an armature, slide it carefully into the fields, lifting the oil ring furthest into the motor, until the threaded end projects from the bearing, having the key uppermost. Now put in the pinion, with keyway at top, and with a small lever pry the pinion and chain into line with the shaft. Lift the remaining oil ring by means of a scriber or similar implement passed through the pinion, and push the armature into place. The lifting of the oil rings is necessary only with motors of earlier construction, the rings being lifted automatically with those recently built. Before sliding the shaft through the pinion, drop the special nut into its place, with its collar within the flange on the pinion and screw it firmly to its bearing, locking with the additional nut provided for the purpose. Put back the head with the commutator bearing, having, in the case of the older machines, removed the plate 71 at the end to admit of lifting the oil rings, and bolt in place. Make the electrical connections as before and replace the brushes. While the pinion hole in gear case cover is still open, turn the armature by hand to make sure the chain runs freely, and then run by power for the time necessary to pump up the pressure in the reservoir. Finding the action all right close the gear case, using the gasket supplied with this cover.

The motor cradle is so designed that the above operations may be readily performed with the compressor in place under the car, and neither operation

should take a man who is provided with our regular set of wrenches more than ten minutes each when he has become at all accustomed to it.

To remove a field coil the compressor should be taken from the car, and as this operation is so easily performed with our method of suspension when the pit is equipped with a suitable jack, we strongly recommend that railroads using our equipment provide themselves with one or more extra compressors, that a defective one may be promptly replaced and the repairs made at the bench in the day time to far better advantage than is possible under the cars at night.

With such an equipment all but the very minor repairs can be profitably handled in this way, and with the cars in the barn a minimum length of time.

Clean the suction strainer once a week when oiling, for if it is permitted to become choked with dirt the efficiency of the compressor is greatly reduced.

Every six months the oil should be drained from the various receptacles by means of the orifices provided for this purpose, and all grit and foreign matter rinsed out with gasoline. Then refill with clean oil. At the same time remove the valves and clean them and their cavities with gasoline.

If a pounding develops in the compressor remove the crank case cover and close the crank bearings of the connecting rods, by removing some of the washers provided for this purpose. Never leave an unfilled gap between the two parts of the rod, as in that case the strap would be loose on the rod when the lining be-

came a little worn. Be sure to tighten the lock nuts and replace the cotter pins.

To get at the piston packing rings or wrist pin it is necessary to detach the connecting rod from the crank shaft, and after removing the cylinder head, draw the piston out this way.

The best results are obtained with a lift of suction valve of $\frac{1}{8}''$, and $3/32''$ for the discharge; it is well, therefore, not to permit pumps to run with a much greater lift than the above.

If a given compressor blows its fuse (a Noark of capacity called for in table on page 20) frequently, and the motor is found to be in good order, it may be assumed that the pump is not working freely; examination will probably show that the discharge valves are sticking, or that there is undue friction of the pistons in their cylinders due to lack of proper lubrication, or a bearing may be running hot for lack of oil. Something certainly will be found wrong, and under no circumstances should the car be sent out with a heavier fuse in the block; such a practice is almost sure to result in burning out the motor.

We decline to assume any responsibility for damage that may occur to compressors which have not been proprly lubricated.

The Chain Drive.

As shown in Fig. 4 the teeth of the pinion are so formed that the chain will fit over them properly in one way only, *i. e.,* with the projections of the center guiding

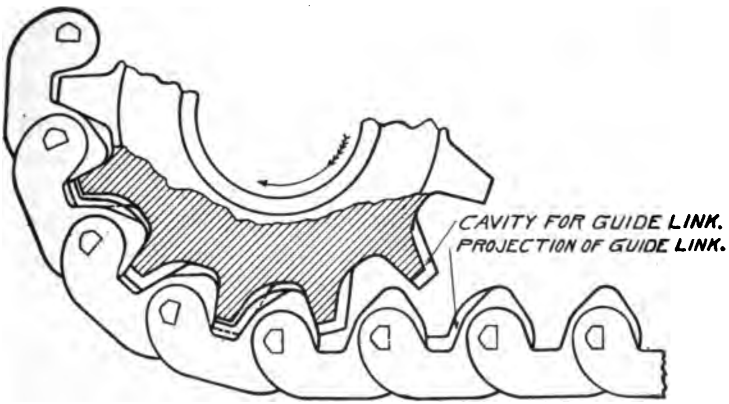
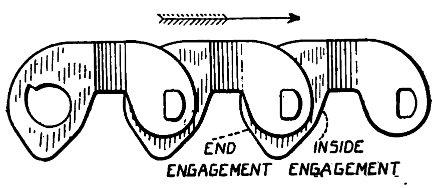


Fig. 4.

links in the corresponding cavities cut in the *back* of the teeth. Thus these cavities in the back of the teeth readily show the direction of rotation of the armature—clockwise. From this it is apparent that the chain is driven, with the small end of the link forward, by the pinion



teeth bearing on the rear end of the links, (end engagement); consequently the sprocket wheel is driven by the inside surface of the large part of the links (inside engagement) bearing on its teeth. The chain, on account of its guide links, cannot be slipped onto the wheels when

they are spaced as in running position; it is necessary that the motor be loosened on its base and slid up toward the compressor; or the chain put in place with the pinion removed from the armature shaft. In the latter case the pinion should be put in its place in the chain and the armature shaft pushed into it.

During the first three or four months of its service,

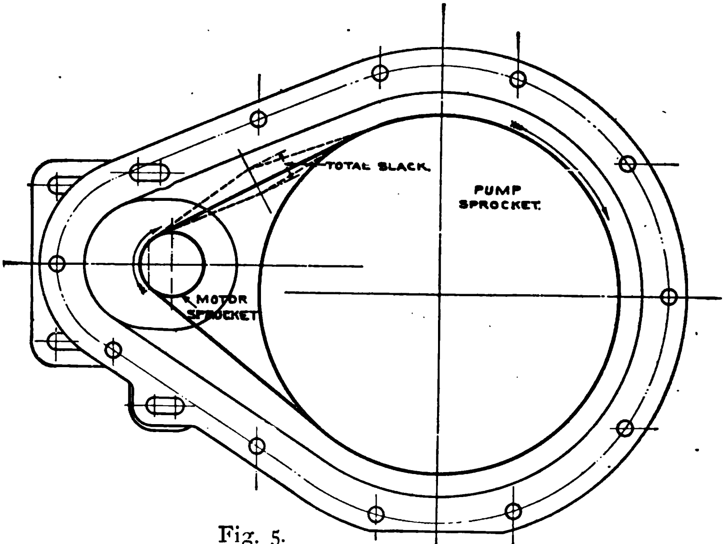
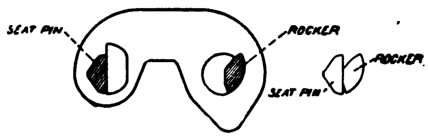


Fig. 5.

the chain may stretch a little, but after it has become well seated on wheel and pinion, the stretching will thenceforth be exceedingly slow. The chain runs best when the distance between the pump and armature shafts is such that its *total slack* when measured as shown in Fig. 5 is one-half ($\frac{1}{2}$) of an inch; under no circumstances should it be permitted to exceed seven-eighths ($\frac{7}{8}''$) of an inch. The amount of total slack is determined as follows: With a force of about ten pounds, depress the chain at a

point on the slack side midway between its point of contact with pinion and wheel, as shown by lower dotted line, and measure the distance from the top of the chain at this point to the inner edge of the gear case. In a similar way, raise the chain as shown by the upper dotted line, and again measure the distance to the gear case; the difference between these two measurements is the *total slack*. Having so placed the motor as to give the desired amount of slack, *first* tighten the four bolts by which it is secured to the gear case, thus drawing the armature shaft into its position parallel with the crank shaft, *then* tighten the four cap screws by which it is fastened to the base.

Although on repair orders we always send out the chains connected up of the proper length, and a worn chain cannot be repaired by taking out a link, still a few lines here as to method of connecting a chain may be of value: Draw the ends of the chain together, swinging the outside links inwardly free of the line of holes. Pass a pointed drift through the holes in the remainder to bring them in line, and follow it up with the *seat pin;*



swing one outside link back into position to receive shouldered end of seat pin. Next *be sure* to insert the rocker pin with its angular face against the flat face of the seat pin as shown in cut; swing the other outside link in position raising it to pass over the seat pin and rivet securely. A chain may be run until, owing to increase in pitch length, it mounts nearly to the top and almost slips over the teeth of the driven wheel; then it is worn out and must be replaced with a new one.

Motor-Driven Air Compressors.

Comp. No.	Cylinder Size Inches	Revolutions per Minute		Cubic Feet Free Air per Minute	E. H. P. at 90lbs.	Amperes	
		Pump	Armature			Am't	Fuse
D-1B	5 x2 11/64	265	1200	13.1	3.18	4.3	5
D-2B	5½x4¼	243	1100	23.4	5.40	7.3	10
D-3B	7 x5	162	830	36.0	9.20	13.7	15

Comp. No.	Dimensions, Inches			Weights, Pounds		
	Length	Width	Height	Pump	Motor	Total
D-1B	26	23¼	16	336	297	633
D-2B	30⅝	27⅛	19¾	437	481	918
D-3B	33¾	28½	22¼	626	559	1185

NOTE—These compressors have their suction orifice tapped for 1" pipe and their discharge orifice for ¾" pipe.

The data as to speed, capacity, etc., is based on an E. M. F. of 550 volts direct current.

January, 1904

Instruction Pamphlet No. T 5003

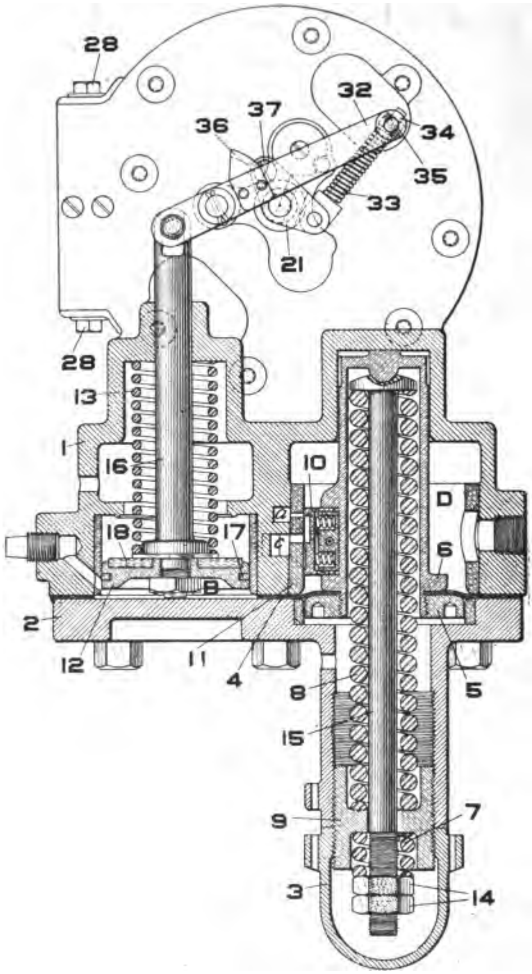
Electric-Pump Governor, Form E

WESTINGHOUSE TRACTION BRAKE CO.,

26 Cortlandt Street,

New York, U. S. A.

FIGURE I.



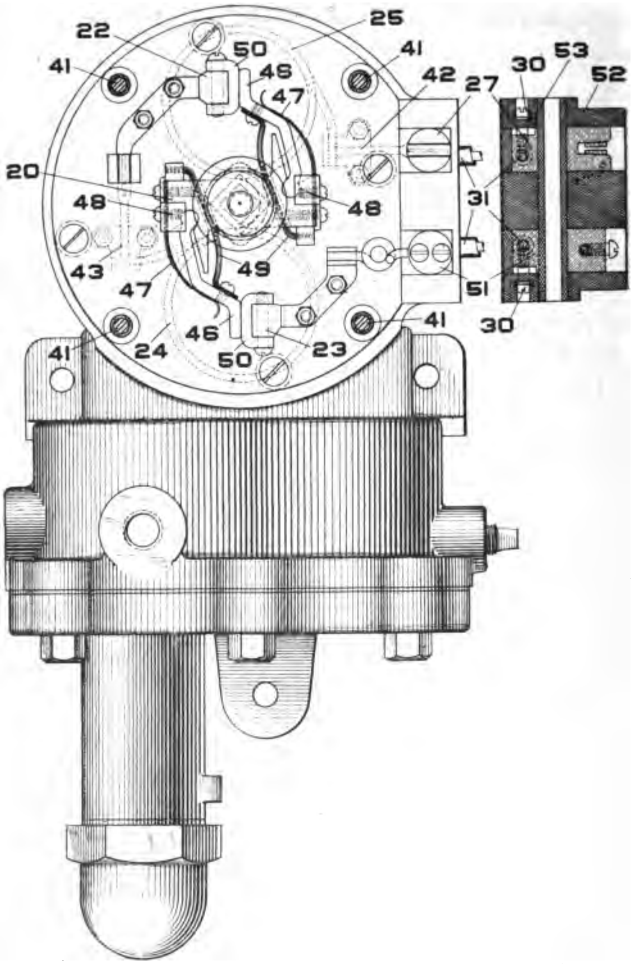
COMPRESSOR GOVERNOR, FORM E.

Electric-Pump Governor, Form E.

The location of the Electric-Pump Governor in the brake system is indicated in Fig. 2, Instruction Pamphlet No. T. 5001. The purpose of the Governor is to start and stop the Compressor automatically when certain predetermined minimum and maximum air pressures are reached by alternately making and breaking the motor circuit.

The Form E, Pump Governor, is shown in rear view with vertical section through the pneumatic part in Fig. 1, on opposite page; in front elevation with the blowout magnets removed in Fig. 2 on the next page, and in plan with section through the electrical parts in Fig 3, page 6. It consists of a pressure chamber D, in free communication with the reservoir, one wall of which is formed by the diaphragm 4. This diaphragm is therefore subjected on one side to reservoir pressure, and on the other side to the pressure of the atmosphere and a regulating spring 8. Secured to the diaphragm by means of the nut 5 is the guide 6 in which spring 8 is seated. The other end of this guide is supported in a suitable cavity in the body 1, and it has a recess in which is fitted the slide valve 10, so that the movement of the diaphragm is transmitted to the slide valve without lost motion. This valve bears on the seat 11 which is provided with a narrow rectangular admission port *a* leading to chamber B. In this chamber is fitted an operating piston 12, which works against the pressure of the spring 13. This piston, in addition to the packing ring 17, is provided with a leather disc 18, which seats on the circular projection at the bottom of this cylinder and prevents any loss of air.

FIGURE 2.

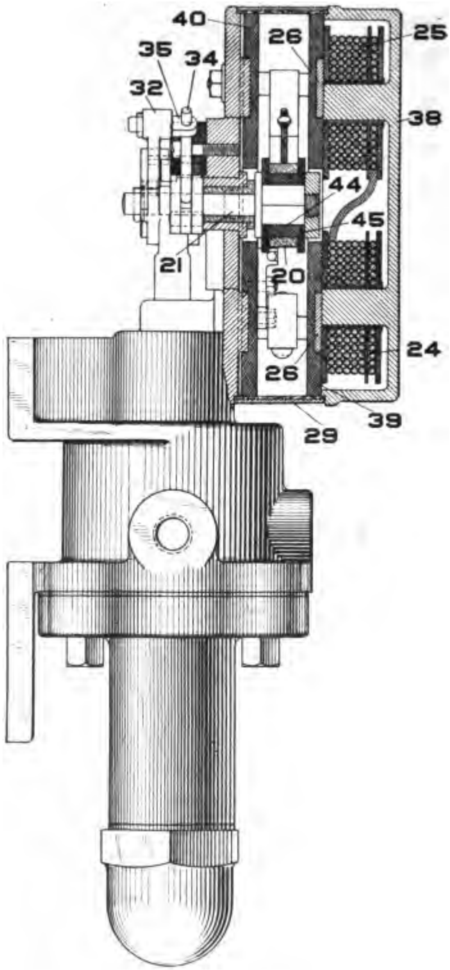


COMPRESSOR GOVERNOR, FORM E,
Front View.

The valve seat also has an exhaust port *c* (leading to the atmosphere) so located that the cavity in face of valve 10, spans the two ports. Thus when maximum pressure is attained the adjustment of the spring 8 is such that the admission port is slightly uncovered and air from the pressure chamber of the governor passes into chamber B and forces piston 12 to the outer end of its stroke, thereby opening a switch in the circuit of the motor compressor, as explained further on. When the pressure in the main reservoir, and consequently that in the pressure chamber, falls, the spring tension now being greater than the air pressure on the diaphragm, forces the valve back until the admission port is connected to the exhaust, when the air in chamber B is released, spring 13 returns piston 12 to the position shown, thereby closing the switch that automatically controls the operation of the motor.

The switch consists of an arm 20, Figs. 2 and 3, mounted on the rocker shaft 21, but insulated from it by the bushing 44 and washers 45. Two contact fingers 46 are pivoted in the arm 20 and held in place by the half elliptic springs 47 and their clamps 48, while the flexible copper shunts 49 protect the springs from any possible heating effects of the current. This arrangement insures perfect contact between the fingers and the removable contacts 50 of the switch terminals 22 and 23. These terminals are bolted to the insulating disc 40 which in turn is screwed to the body of the governor. In series with terminal 22 are connected two blow-out coils 24 and 25, which have the inside end of one joined to the outside end of the other that one of the poles 26 may be a north and the other a south pole, thus giving a strong and effective magnetic blow-

FIGURE 3.



COMPRESSOR GOVERNOR, FORM E,
Side View.

out. These coils are secured in the cover casting by means of the fibre insulating disc 39, and this entire group may be removed from the governor by taking off the nuts on the four studs 41 thus exposing the switch and its contacts for inspection. The free end of coil 25 is joined to a connector 42, which projects through the disc 39, and fits into a slot provided for it in main terminal 27, while the free end of coil 24 has a connector 43 which fits into slot in switch terminal 22. Switch terminal 23 is connected directly to main terminal 51, consequently when the blow-out coils are in place the closing of the switch completes the circuit between main terminals 27 and 51. These terminals are imbedded in the terminal block 52 and are held in place by the insulating tube 53, as shown in the small sectional cut of Fig. 2.

To make the outside connections it is necessary to take out the bolt 28 (Fig. 1), when, upon removing the band 29, the binding screws 30 will be disclosed. Insert the wires as shown at 31 and replace the band, thus concealing all live points, avoiding the use of connectors and effectively preventing tampering with the circuit by passengers.

The rocker shaft 21 and the operating lever 32 are pivoted eccentrically, the upper ends of the rocker arm and the lever being connected by a compression member consisting of a spring 33 and its stem 34, which is pinioned to the rocker arm at one end and slides through the guide pin 35 in the end of the lever, which pin also serves as an abutment for the spring 33. As piston 12 moves outwardly it drives the upper end of lever 32 in the opposite direction, compressing spring 33 until the detent 36 passes pin 37 when spring 33 snaps the switch arm

20 open with a very quick movement. The reverse movement of piston 12 closes the switch with a quick motion similar to that of opening. Except at these moments of transition the switch is held either open or closed by the tension of spring 33; there is no intermediate position of the switch possible.

The pressure at which the governor cuts the compressor out of action is adjusted by turning the nut 9. The cutting in pressure is dependent on the amount of compression of the retarding spring 7 which may be adjusted by the nuts 14. This adjustment must be made after the cutting out pressure has been regulated, and we recommend a drop of 12 to 15 pounds, according to the operating conditions, it being desirable to have the compressor cut into operation only after three or four applications of the brake have been made. The locking nut 3 is made in form of a cap, and is provided with a hole at each of its hexagonal points, that the wire of a car seal may be passed through one of them and the corresponding hole in a lug on the head 2, thereby preventing any tampering with the governor after it is set.

INSTALLATION OF THE GOVERNOR.

Compressor governors of the slide-valve type should be secured to a vertical surface in the position indicated by the lettering on the cover. The location which we recommend is on the front wall of the vestibule, just behind or at the side of the brake staff. Fig. 4 shows the governor installed in this manner, and it will be noted that a wide board is screwed to the framing of the vestibule, the board having previously been fitted with three $\frac{3}{8}''$ bolts, properly spaced to secure thereon the governor.

On this board directly under the governor is the best place for the fuse block. If the car is operated from both ends, and consequently the passengers have access to the platforms, a cover in the form of three sides and top of a box should be provided, which effectively conceals these parts and yet may be readily removed for inspection without the aid of tools.

On open cars, or whenever it is considered impracticable to install the governor as above described, it may be placed under an inside end seat, but its position and the relative location of the various fittings should always be the same. If under a cross seat, it should be covered with a box, which may be removed on lifting the cushion.

From the $\frac{3}{8}''$ tapped outlet in the pressure chamber of the governor run a pipe direct to the $\frac{3}{8}''$ hole, provided for that purpose in the reservoir head at the end opposite that at which the air enters from the compressor. In this pipe should be placed at a point near the governor in the order mentioned, the $\frac{3}{8}''$ union, insulating joint and stop cock which are provided for this purpose. In this way the governor is well insulated from any possible ground connection, which is essential to this apparatus.

Oiling and Adjusting the Governor.

Once a month the valve of the Governor should be lubricated by putting in through the pipe-plug opening a few drops of good oil. Twenty-eight degrees gravity West Virginia crude oil is best for such purposes, as it does not gum; but engine oil may be used if the West Virginia oil cannot be obtained. The governor should be set to cut the compressor out at 65 pounds pressure with the straight-air equipment,

and 95 pounds with the automatic equipment, and to cut in at about 50 to 53 pounds with the straight-air, and 80 with the automatic set, so that at least three applications of the brake may be made before the compressor is again started.

To adjust the governor remove check nut 3, Fig. 1, and run back the two half-inch nuts 14. By means of a suitable spanner, turn the adjusting plug 9 until the governor opens the circuit at the desired pressure. Now advance the first nut 14 until the retarding spring has about 1/32" play along its stem 15 when the reservoir pressure is at its maximum. Reduce the pressure in reservoir slowly and if the pump cuts in too quickly advance this nut 14 still further. If, however, the drop in pressure is greater than desired, slacken this nut 14; when the proper regulation has been obtained, tighten the lock nut on 14 and replace the check nut 3. If it is found that the governor cuts in at a higher pressure when the reduction is very slow, notice by holding a lighted match close to the exhaust opening, if the slide valve is leaking. Should the valve prove to be tight, there must be a leak past the piston 12 and its packing ring and leather should be examined.

FIGURE 4.

O. V. J. OPERATING VALVE AND FORM E.
GOVERNOR INSTALLED ON A CAR.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	1545 Railway Exchange Building
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
Los Angeles, Cal.	621 Trust Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .003

July, 1904

Instruction Pamphlet No. T 5003—G

Electric-Pump Governor Form G

WESTINGHOUSE TRACTION BRAKE CO.,

26 Cortlandt Street,
New York, U. S. A.

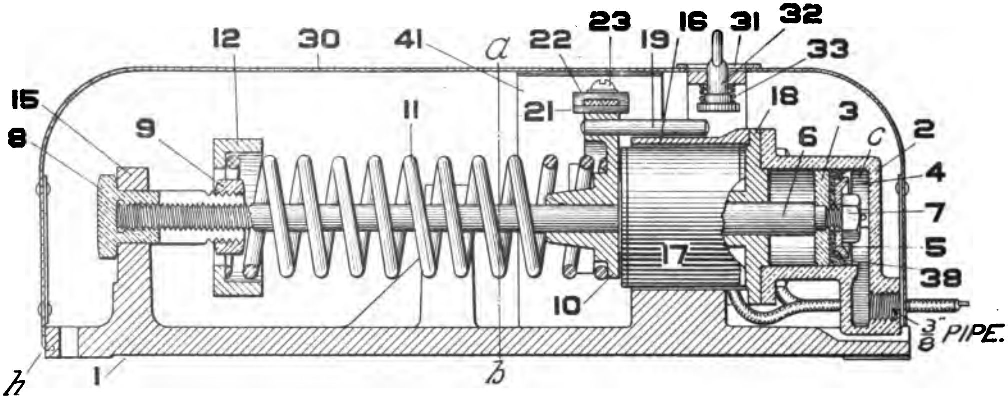


Fig. 1. Section through center of Governor.

ELECTRIC-PUMP GOVERNOR

FORM "G."

The Electric-Pump Governor, Form "G," is the simplest and most reliable device as yet brought out for the purpose of automatically controlling the operation of air compressors which are driven by series-wound electric motors. As will be noted by the cuts accompanying this Pamphlet, the essential parts of this governor differ very considerably from those of previous construction in the relation they bear to each other. There is no valve mechanism nor any levered-electric-switch connection. The design and operation of the mechanism is extremely simple, and the number of parts and the wear of same is reduced to a minimum. Generally speaking, the governor consists of a small air cylinder in which a piston operates, the latter being moved by air pressure on one side and a combination of spring and electro-magnetic pressure on the other side, and by moving, throws in and out a simple set of electric contacts, thereby making and breaking the circuit to the electric motor.

Fig. 1 is a vertical section through the center of the complete governor; Fig. 2 is a plan view with the cover removed; Fig. 3 a view of the cylinder end, with a portion of the cover cut away; Fig. 4 is a section through the governor on the line *a-b,* Fig. 1, looking towards the cylinder, the cover and spring being removed.

Referring to these cuts, it will be seen that the cylinder 2 has working in it a piston 3. The piston rod 6 carries a casting 10, against which is seated one end of the compression spring 11; the other end of this spring

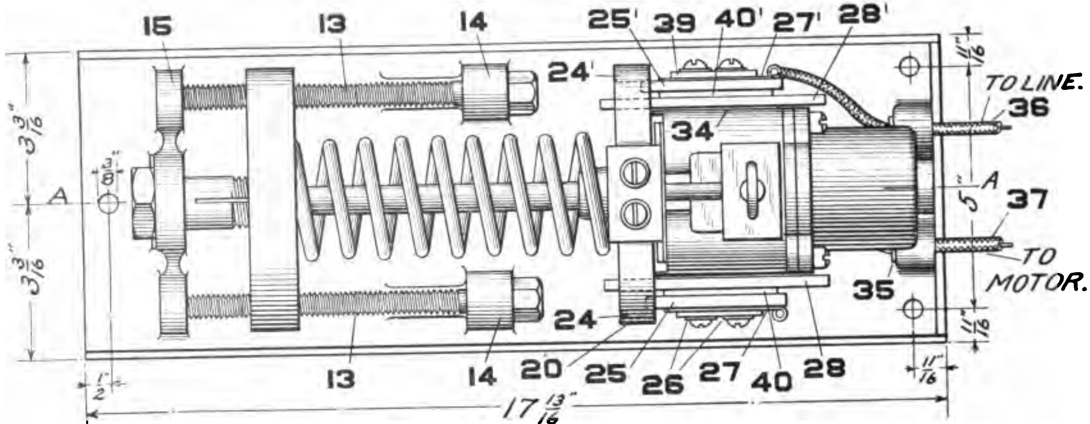


Fig. 2. Plan view with cover removed.

seats against the yoke 12, which yoke can be adjusted as to its position along the axis of the governor by the two bolts 13 (Fig. 2). In this manner, any desired tension may be put upon the spring 11. The chamber *c*, back of the piston in cylinder 2, is connected directly to the main reservoir, so that the piston 3 is always subjected to reservoir pressure, and consequently its position in the cylinder, and also that of casting 10, depends, so far as we have described, upon the difference in the pressure on the piston and the tension of spring 11.

Mounted upon casting 10 and electrically insulated from it is a suitable circuit closer 20 (Figs. 2 and 4), which has removable tips 24 and 24′ that can be renewed at any time. Upon the side of the cylindrical casting 16 are fastened two fixed contacts 25 and 25′, which are joined each to one end of a break in the electric circuit to the motor-driven compressor. Thus, when the load on the piston is less than the tension of the spring, this break in the circuit is closed. When the air pressure increases sufficiently to compress the spring enough to admit of it, the contacts 24 and 24′ would slip off of the fixed contacts 25 and 25′, thereby opening the compressor circuit; and, on the other hand, when the air pressure decreases, the spring would force the piston back and make contact in the same manner. Such a form of automatic governor is undoubtedly the simplest possible, but without any other mechanism is entirely impracticable, because the making and breaking of the circuit is so slow that the contacts would readily burn up. The complete overcoming of this difficulty is the essential feature of this governor, and is accomplished in the following manner:

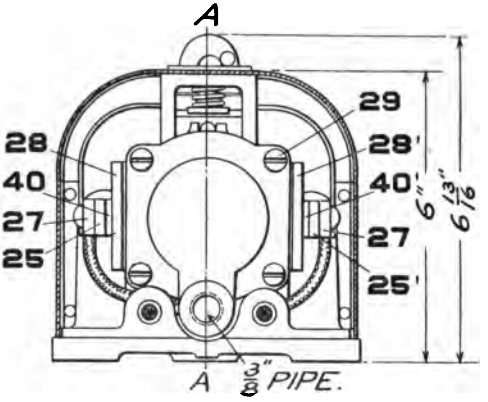


Fig. 3. Cylinder end, with portion of cover cut away.

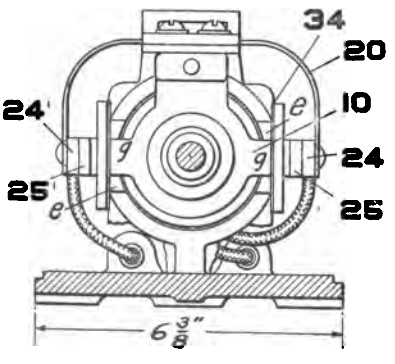


Fig. 4. Section on line *a*—*b*, looking toward cylinder. Cover and spring removed.

Between the cylinder 2 and the casting 10 (Fig. 1) is the cylindrical shell 16, which, projecting up from the cast iron base 1, has its axis coincident with that of the piston rod 6. In this shell is fitted a coil of insulated wire, which is wound upon an iron core having a suitable flange 18, by which the coil is fastened to the shell 16. The four cap screws 29 pass through this flange as well as that of cylinder 2, thereby securing them both firmly to the shell 16. Thus the parts 16, 17 and 18 constitute an iron-clad electro-magnet, of which the casting 10 forms the armature. One lead of the magnet coil is connected to the fixed contact 25 and the other to the motor lead 37, while positive lead 36 is connected directly to contact 25', consequently the connecting of contacts 25 and 25' by the movable circuit closer 20 completes the circuit, and, when the current is on same, immediately energizes the magnet, thereby putting an additional load on the piston rod in opposition to that from the piston.

Consequently, when a reduction in the air pressure takes place, the tension of the spring moves the circuit closer 20 towards 25 and 25'; the instant they touch, the resulting flow of current energizes the magnet, which instantly tends to bring the armature toward it with a jerk, thereby putting the contacts into immediate and full engagement. This action effectively prevents any burning upon closing the circuit. With the compressor in action, as the air pressure increases, the load upon piston 3 would at once begin to compress the spring 11, were it not for the effect of the electro-magnet, which effect is now at a maximum owing to the close proximity of the armature to the magnet, thus preventing any movement until the

air pressure has been materially increased. Consequently, when the pressure against the piston is sufficient to overcome the combined force of the magnet and spring, the armature casting 10 begins to move away from the magnet; as the power of a magnet decreases with the increase of gap between it and its armature, and does so faster than the tension of the spring increases, the rate of movement of the piston rod and armature 10 increases more and more rapidly until the circuit is broken at the contacts, when the electro-magnet loses all its power and the entire load is thrown upon the spring with the result that the armature casting 10 and its circuit closer 20 are forced away from the magnet and fixed contacts with a very quick movement.

To further assist in extinguishing the destructive electric arcs, the magnetic shell 16 is provided with pole pieces *e e* (Fig. 4) and the armature casting 10 with pole pieces *g g*, which are in close proximity to the contacts, and thus form an effective magnetic blow-out.

The pressure at which the governor will cut the compressor into action depends entirely upon the tension of spring 11 (Fig. 1), which tension is adjusted by the screws 13. The excess of the cutting-out pressure depends entirely upon the strength of the magnetic pull. As this pull depends upon the proximity of the armature to the poles of the magnet, the cutting-out pressure is regulated by the adjustment of the stop 8 which, sliding with the extended piston rod through a hole in the guide post 15, limits the closing movement of the armature. This stop 8 turns upon the threaded piston rod and is split at one

end, so that by tightening the nut 9 it may be clamped firmly upon the rod and avoid any possibility of working loose and changing the adjustment. The maximum difference of pressure is obtained when stop 8 is slackened back far enough to allow the armature to come into actual contact with the magnet. By advancing this stop the gap at the magnetic poles is increased and the difference between the minimum and maximum pressures is decreased.

The cover 30 is made of galvanized sheet iron and is provided with a flange which enters under the base at *h*, thereby securing it at that end. The other end is fastened by the thumb latch 32, which should be turned one-quarter way around after this end of the cover is in place. A hole in the latch is provided for the insertion of a padlock, so that the governor may be locked after adjustment to prevent any tampering with it.

As stated above, the design as a whole constitutes a simple but substantial governing mechanism with very few moving parts, and the wear on these extremely small. The principles involved in its operation are so simple as to be easily, quickly and thoroughly understood by those having supervision over the apparatus, thus assuring its maintenance and efficiency. The method of adjustment for both cutting-in and cutting-out pressures is simple and the regulation can be made with great accuracy. The whole device is light and easily installed, and can be gotten at for inspection immediately without the use of any tools.

Installation and Maintenance

We recommend that the governor should be fastened to a vertical surface with its long axis vertical and the spring end uppermost; or with brake equipments it may be secured to the floor under a seat. When installed in connection with stationary plants where it is always in a warm room such that any moisture that might be carried into the governor cylinder could not freeze and cause the piston to stick, the relative position of the governor is immaterial. But where it may be subjected to temperatures below freezing it is advisable that its position be such that moisture will always drain out of the cylinder. For the purpose of securing it, three holes are provided in the base. Wherever it is placed, it must be insulated from ground and protected from moisture. The ⅜″ pipe-tapped orifice in the cylinder casting should be connected directly to the ⅜″ hole in the reservoir head, and near the governor should be placed in this pipe a union, an insulating joint, and a stop-cock, in the order named. The latter should be so located that there is no possibility of its being closed by a broom when the car is being swept. We recommend putting the governor on the positive side of the motor; when so placed, the lead 36 which is fastened to clip 27 and contact 25 *must be connected to the line side of the circuit,* and lead 37 coming from the coil *must be connected to the motor.* In any event, lead 36 must be connected to the positive side and lead 37 (which comes direct from the coil) to the negative side of the circuit. Care must be taken that the yoke 12 should be kept square with the axis of the governor

when adjusting the tension on spring 11. We do not guarantee a governor should it be regulated to cut in with a reduction of less than 12 pounds.

Contacts 25 and 25′ are symmetrical and can be turned over, and also the ends reversed before they are worn out.

The inside of the cylinder 2 should be cleaned and lubricated and the piston packing leather 4 softened every three or four months. For this purpose we would recommend the use of a light non-corroding grease.

Westinghouse Traction Brake Company

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

BRANCH OFFICES

Boston, Mass	53 State Street
Cleveland, O	New England Building
Chicago, Ill	1545 Railway Exchange Building
Cincinnati, O	1111 Traction Building
St. Louis, Mo	American Brake Co., 1932 N. Broadway
Los Angeles, Cal	621 Trust Building
Pittsburg, Pa	At Wilmerding Works

P. F. No. 157

January, 1904

Instruction Pamphlet No. T 5004

Wiring
of
Motor-Driven-Compressor Brake Equipments

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

Wiring.

The wiring which connects the main trolley circuit with the motor-compressor and the compressor governor should be installed according to instructions given below, and include the following apparatus:

COMPRESSOR SWITCHES—These are of the Perkins single-pole, double-break, snap-switch, indicating type, having a porcelain base upon which the contacts are mounted in the usual manner, a nickeled metallic cover, lined on the inside with insulating material, and on the rotating spindle, a disc having upon it the words "On" and "Off" which pass behind a special opening in the front of the cover and indicate when the circuit is made or broken respectively.

FUSE BOX—The fuse which we supply is the "Noark." The box is our own construction, and consists of an iron case in which is placed a slate base having suitable clips to hold the fuse in place, suitable binding posts for the wires, and an iron cover which fully protects the interior but is hinged on one side and held on the other by a thumb nut, so that it is easily and quickly opened without the aid of tools.

INSTRUCTIONS FOR INSTALLING THE WIRING.

The wiring should be installed in a thorough manner, great precaution being taken to avoid the possibility of grounds developing after the car has been in service for a time. Whenever practicable, the wiring should be run inside the car, securely cleated in place, and must always be so located that it may not be damaged when the body is being jacked up. At exposed places underneath the car and particularly at those points where the wire comes in contact with iron, it must be covered with rub-

ber tubing. The size of solid rubber covered braided wire which we recommend for the Nos. 1, 2 and 3 compressors when operating on standard railway voltage is No. 14 B. & S. gauge. Although smaller sizes might do the work without excessive drop in voltage or danger of over-heating, still they lack mechanical strength and a smaller wire than No. 14 is undesirable on this account. Under these conditions the No. 4 compressor should be wired with No. 12 B. & S. gauge.

The sequence in which the various parts should be connected is shown in Fig. 2, Instruction Pamphlet No. T 5001, but the *point at which the compressor circuit shall be tapped to the main trolley line* is one to be determined in each individual case. We do not recommend connecting inside the main motor choke coil, for, although the apparatus of the compressor circuit will be protected by the lightning arrester on the car motor circuit, there are many drawbacks to this method, viz.: (*a*) The blowing of the main fuse opens the compressor circuit; (*b*) when laying over at the end of line it is customary to open the overhead switch, consequently compressor cannot maintain reservoir pressure; (*c*) with automatic circuit breakers at each end of car, when running with the motorman at the opposite end to that at which the compressor circuit is attached, the motorman may forget to close the breaker, which is then needed for the compressor only; (*d*) in the barn it is often desirable to have current on the compressor circuit when it is not wanted on the controllers.

By tapping on the trolley line outside the main switches we overcome all these disadvantages, and if the connection is made between the first main switch and the point where the light circuit is tapped off, *and the lamp*

circuits are turned on during storms, a very efficient lightning arrester is provided. The better plan, of course, is to provide a separate arrester for the compressor circuit which involves only a slight additional expense.

From the trolley connection, run the wire first to one compressor switch and then to the other, connecting them in series, and making sure that when they are open, their dials show the word "Off." and when closed, "On." Thence through the fuse box to the governor where, with the Form E type, the connection may be made by either of the two holes 31, in the insulating block 52, Fig. 2, Instruction Pamphlet No. T 5003. The binding screws 30 will be disclosed after taking out bolt 28 and removing the covering band 29. With the Form G Governor, the line connection should be made directly to the fixed contact which is not in series with the electromagnet. From the remaining terminal run a wire to the motor where the *connection must be made to the field lead* which comes out of the frame at a point near the door. The armature lead must be connected to the main motor ground wire; by this means a grounded field coil or lead can cause no damage to the armature. The positive wire leading to the motor, and the ground return from same should, under no circumstances, pass through the same hole or be cleated together, but should be kept three or more inches apart.

THE COMPRESSOR SWITCHES, one at each end, should be placed within easy reach of the motorman without necessitating his moving from his customary position. Fig. 4, Instruction Pamphlet No. T. 5003 shows this switch so located, with a little shelf over it to protect it from the rain or from getting caught in the trolley rope; it is also rendered less conspicuous to passengers.

THE FUSE BOX should be connected between the last compressor switch and the governor. It ought not to be so placed that a screw-driver or other implement is needed to get at it, but should be easily accessible, in a dry place with its box well removed from any possible ground connections.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	1545 Railway Exchange Building
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
Los Angeles, Cal.	621 Trust Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .007

January, 1904

Instruction Pamphlet No. T 5005

Reservoirs

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

The Reservoir.

STRAIGHT-AIR BRAKE EQUIPMENT.

The Reservoir is provided for the purpose of storing the compressed air to apply the brakes. It should have a capacity sufficient to supply air for three or four applications of the brakes without reducing the air pressure more than 12 or 15 pounds.

It also entraps any water, oil or dirt that is brought in by the compressed air, thereby preventing same from being carried further into the brake system. It should be drained every day, the drain cock being left open while in the barn, in order to completely remove any oil and water from the space provided for storing air, as a reservoir partly filled with water is correspondingly reduced in capacity.

The Reservoir is made of sixteen-inch tubing with welded heads, having re-enforced tapped openings for the pipe connections. It is of the same construction as those made by the Westinghouse Air Brake Company for passenger car service.

The weight of the car determines the size of brake cylinder to be used, which in turn determines, to a great extent, the capacity of the reservoir. It is very important that the reservoir should have sufficient capacity, and hardly possible for it to have too much. If it is too small, every ordinary application of the brake will throw the compressor into action, thus keeping the latter in a constant state of starting and stopping, and causing unnecessary wear to both compressor and compressor governor. Assuming an average piston travel of eight inches, the volume of an eight-inch cylinder

is approximately .23 cu. ft. As the piston is against the pressure head of the cylinder before the brakes are applied, it is evident that when it has moved eight inches, .23 cu. ft. of free air must be supplied to equalize the pressure inside the cylinder with that outside. To raise this to 50 pounds gauge pressure will require $\frac{50}{14.7} = 3.4$ volumes of free air additional, or in all $1 + 3.4 = 4.4$ volumes, which $= 4.4 \times .23 = 1$ cu. ft. of free air approximately. Consequently four applications of the brake, where the cylinder pressure becomes fifty pounds, requires four cubic feet of free air. Therefore, the volume of the reservoir should be such that, with sixty-five pounds pressure, the drawing off of four cubic feet of free air should not lower that pressure more than, say, 12 pounds.

Four cubic feet of free air in a reservoir subjected to 65 pounds gauge pressure, or $\frac{65 + 14.7}{14.7} = 5.4$ atmospheres, would be reduced to a volume of $\frac{4}{5.4} = .74$ cu. ft. In reducing the reservoir pressure 12 pounds, the quantity of air taken from it will be $\frac{12}{65 + 14.7} = .15$ of the original volume. Consequently, .74 cu. ft. must be .15 of the entire reservoir volume, making the volume of the reservoir $= \frac{.74}{.15} =$ practically 5 cubic feet. Figuring on this basis, we recommend the following sizes:—

With	8″	brake cylinder	use	16″ x 48″ reservoir.
"	10″	" "	"	16″ x 60″ "
"	12″	" "	"	16″ x 72″ "

Although the above are considered to be standard sizes, the dimensions may be varied whenever circumstances warrant. The lengths given are "over all."

AUTOMATIC AIR BRAKE EQUIPMENT.

With this equipment two reservoirs are supplied, the first of which is called the Main Reservoir, and receives the compressed air directly from the compressor. The second is the auxiliary reservoir, and stores the air for use in the cylinder of that vehicle only. The main reservoir should have a capacity sufficient to store an abundant supply for the purpose of releasing and quickly recharging the brakes. If possible, it should be located in such a manner that all dirt, oil and moisture entrained in the compressed air will drain into it and be deposited there, but location is a consideration subordinate to that of sufficient capacity.

Main reservoirs should also have a drain cock in the bottom side, and be drained regularly whenever the car comes into the barn, in order to avoid the possibility of its capacity becoming reduced.

The remarks just made under the Straight-Air Brake Equipment concerning the desirability of having sufficient capacity for the reservoir, applies equally well to the main reservoir in the automatic equipment. As in this equipment the auxiliary reservoirs are usually of cast iron and combined with the cylinder directly, their volume is already determined and requires no calculation, but as the governor is connected to the main reservoir in these equipments it is equally important that its volume should be sufficient to meet the requirements. As these requirements are likely to be very different in nearly all cases, we do not give here any standard dimensions for these main reservoirs, but will make them to order to whatever size is desirable.

In mounting reservoirs they should be clamped by means of straps provided for that purpose to suitable cleats bolted to the car framing; the cleats should be hollowed out to fit the curvature of the reservoir. The outlet in the side for the drain cock should be placed on the underside.

AXLE-DRIVEN COMPRESSOR SETS.

The standard size reservoir for these sets is 14″ diameter and 40″ long, but such sizes and number will be supplied as the type of car and nature of service may demand. When the two-reservoir system is used, as described in Instruction Pamphlet T. 5013, the above mentioned reservoir is called the Main Reservoir, and a smaller one called the Preliminary Reservoir, generally 12″ in diameter and 20″ long, is connected directly to the discharge pipe of the compressor. This preliminary reservoir connects through a duplex check valve (described in Instruction Pamphlet T. 5009) to the main reservoir. This should be installed as described in Instruction Pamphlet T. 5013, describing the Straight-Air Brake Equipment with Axle-Driven Compressor.

The manner of installing the reservoirs should be similar to that mentioned above, viz., they should be clamped by means of straps provided for that purpose to suitable cleats, bolted to the car framing. Care should be taken that the outlet for the drain cock in the side should be placed on the underside.

STORAGE AIR BRAKE SYSTEM.

The size of storage reservoirs necessary for this system depends upon the conditions under which the road

employing this apparatus operates, and principally upon the distance between charging stations. The storage reservoirs are usually made for a pressure of 300 lbs. to the square inch, and should be fastened to the car framing by being clamped to suitable cleats by means of straps provided for that purpose. Each reservoir is provided with a drain cock, and care should be taken that the outlet in the side provided for this purpose should be placed on the underside. The positions of the storage reservoirs and service reservoirs will have to be decided in reference to the other apparatus which is necessary to be placed under the car, but in all cases we recommend that the relative order of connection between the reservoirs should be made according to the instructions given in Instruction Pamphlet T. 5016.

Westinghouse Traction Brake Company

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"
Telephone, 6950 Cortlandt
Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 008

January, 1904

Instruction Pamphlet No. T 5006

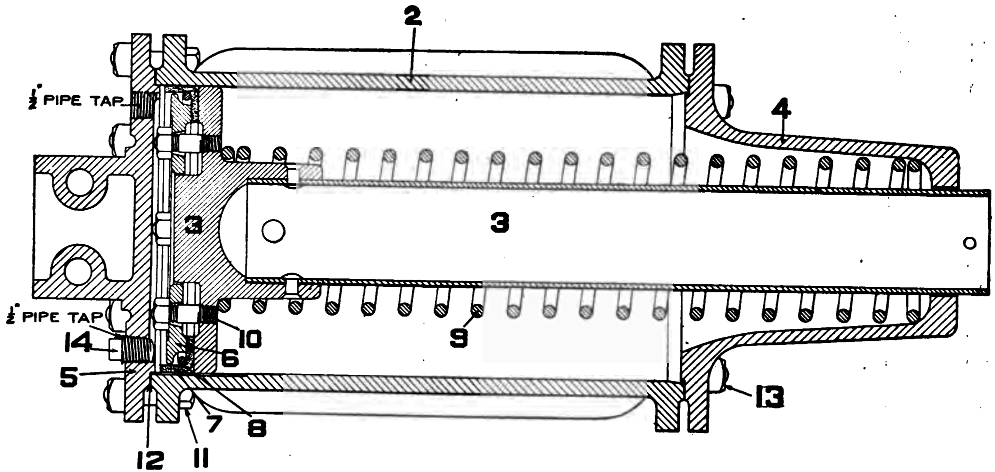
Brake Cylinder.

WESTINGHOUSE TRACTION BRAKE CO.,

26 Cortlandt Street,

New York, U. S. A.

FIGURE 1.



THE BRAKE CYLINDER.

The Brake Cylinder.

The Brake Cylinder illustrated in Figure 1, is of the hollow-rod pattern by which the piston is so connected to the foundation rigging that it moves only when the power brake is in use. 2 is the brake cylinder; 3 is the piston and sleeve in which the push rod, connected with the system of brake levers, is inserted; 4 is the non-pressure cylinder head; 9 is a release spring which forces piston 3 to the release position when the air pressure is released from the pressure end of the cylinder; 7 is a packing leather which is pressed against the cylinder wall to prevent air from escaping past the piston; 8 is a round spring packing expander which serves to hold the flange of the packing leather against the walls of the cylinder; 6 is the follower plate, which, by means of studs and nuts 10, clamps the packing leather to the piston. The pressure-head 5 has two ½″ pipe tapped holes, to one of which the air piping is connected, the other being closed by plug 14. The pressure-head is bolted to the cylinder by bolts 11 and the joint made air tight by rubber gasket 12.

The pressure-head 5, as shown, is arranged for attachment of the American Automatic Slack Adjuster, and is also generally provided with a detachable lever bracket, Fig. 5, so that the slack adjuster may be used or not, as desired. Or it may be added afterwards without necessitating a new cylinder head or any change other than removing the detachable bracket and putting the slack adjuster in its place. When desired we supply a plain pressure head as shown in Fig 2, on the next page.

FOR STRAIGHT-AIR EQUIPMENT.

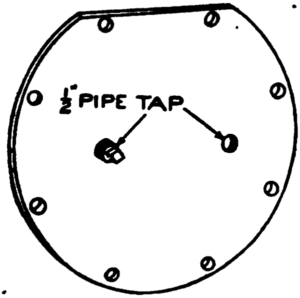


Fig. 2.

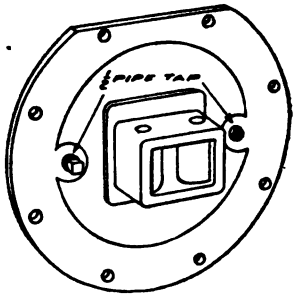


Fig. 3.

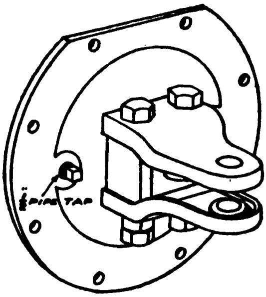


Fig. 4.

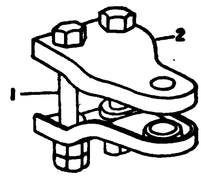


Fig. 5.

PRESSURE HEADS.

Fig. 2, Type O, Plain Head,
" 3, " P, Plain Head with Slack Adjuster Lug,
" 4, " Q, Plain Head with Detachable Bracket,
" 5, Detachable Bracket, complete,
No. 1, Detachable Bracket Bolt and Nut,
No. 2, Detachable Bracket

Note—Unless otherwise specified, the "Plain Head with Slack-Adjuster Lug," shown in Fig. 3, with a detachable lever bracket, the whole appearing as in Fig. 4, is furnished on all orders for or including this part. If orders including Brake or Cylinder Heads also cover Slack Adjusters, detachable brackets are not supplied.

FOR AUTOMATIC EQUIPMENT.

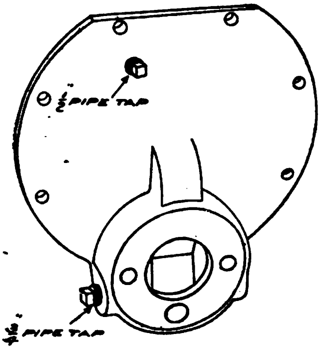


Fig. 6.

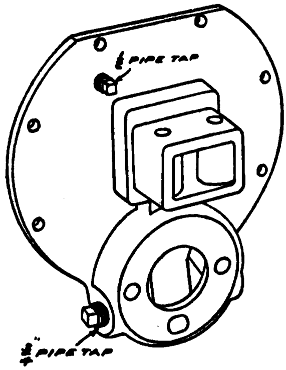


Fig. 7.

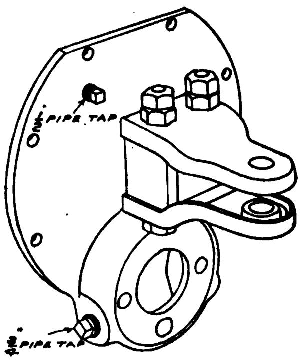
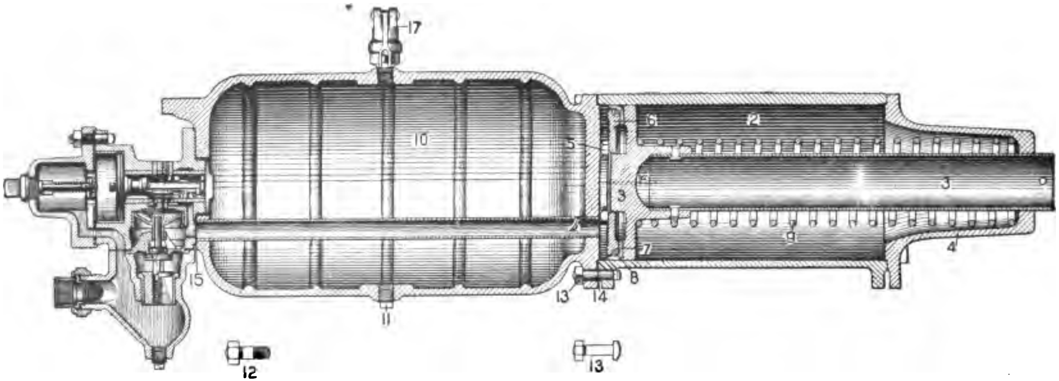


Fig. 8.

These figures illustrate the various types of pressure heads that we supply with brake cylinders of the separated type when used with the automatic equipment, viz.:

Fig. 6, Type R, Quick-Action Triple-Valve Head,
" 7, " S, Quick-Action Triple-Valve Head, with Slack Adjuster Lug,
" 8, " T, Quick-Action Triple-Valve Head, with Detachable Bracket,

FIGURE 9.



THE COMBINED CYLINDER, RESERVOIR AND TRIPLE VALVE.

The Combined Cylinder, Reservoir and Triple Valve.

The Combined Cylinder and Reservoir (Fig. 9) is the usual form of equipment applied with the Automatic Brake. In case of necessity, the cylinder and auxiliary reservoir may be of the separated type and connected by piping; in such cases the auxiliary reservoir and brake cylinder are of the same type as just described for the Straight-Air Equipment, the cylinder having a pressure head, as shown in Figs. 6, 7 or 8, to which is bolted the triple valve. Ordinarily, however, the combined apparatus is the more convenient for traction purposes.

Auxiliary reservoir 10 is simply a hollow shell replacing the wrought iron reservoir used with the Straight Air equipment. Pipe *b* provides communication between the triple valve and the brake cylinder. The operation of the brake is the same, and the functions of the relative parts are identical with those described on page 3; it is simply a different arrangement of the same parts.

In the wall of the cylinder (indicated by dotted lines), is a small groove *a* called the leakage groove. If the exhaust port of the slide valve of the triple valve should, in any manner, become obstructed when it is not desired to have the brakes applied, a slight flow of air into the cylinder from any cause will, instead of forcing the piston out, escape through leakage groove *a* to the atmosphere at the non-pressure end of the cylinder. Valve 17, usually placed above the auxiliary reservoir, is known as the release valve. A rod extends from the arms on each side of this valve to the side of the car, and pulling either rod unseats the valve and discharges air from the reservoir for the purpose of releasing the brake.

Installation.

THE BRAKE CYLINDER when 10″, or less, in diameter should be bolted by six ⅝″ bolts with double nuts to a hard wood plank not less than 2″ thick, 11″ wide, and as long as necessary to secure it to the framing of the car body. Use ¾″ bolts for the 12″, and ⅞″ for the 14″ cylinders, with supporting pieces of proportionately increased strength. The location should be so chosen in relation to the foundation brake rigging of the car, that when the brakes are released the push rod will be at the bottom of the hollow piston sleeve. A union should be placed in the pipe connecting the train pipe to the cylinder at a point to one side of the latter to facilitate removal of the head for cleaning the cylinder.

The combined Cylinder and Reservoir should be secured to the car framing in the same manner as brake cylinders of the separated type. The wood plank should be used for the cylinder end and a suitable piece put in for the end of the reservoir. These equipments are only built in 8-inch and 10-inch sizes, consequently ⅝″ bolts (eight) with double nuts will be sufficient for fastening them to the supporting pieces. In locating the apparatus, note that there should be sufficient room between the top of the auxiliary reservoir and the car flooring to remove the release valve.

INSPECTION AND MAINTENANCE.

In cleaning the cylinder and piston, special attention should be given to removing lint, freeing the leakage groove of any deposit, and thorough cleansing of the expander ring, packing leather, and piston. In oiling or greasing the cylinder, special attention should be given to the thorough lubrication of the top of the cylinder and

the inside of the packing leather where the expander ring rests. A light grease in the cylinders has been found to give the best results. If too much oil be used, it will work back into the triple valve and ruin the rubber-seated valve and the gasket. It should be particularly observed that the follower nuts are tight, since they are frequently found to be loose.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass,	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	1545 Railway Exchange Building
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
Los Angeles, Cal.	621 Trust Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .009

January, 1904

Instruction Pamphlet No. T 5007

Operating Valves

for

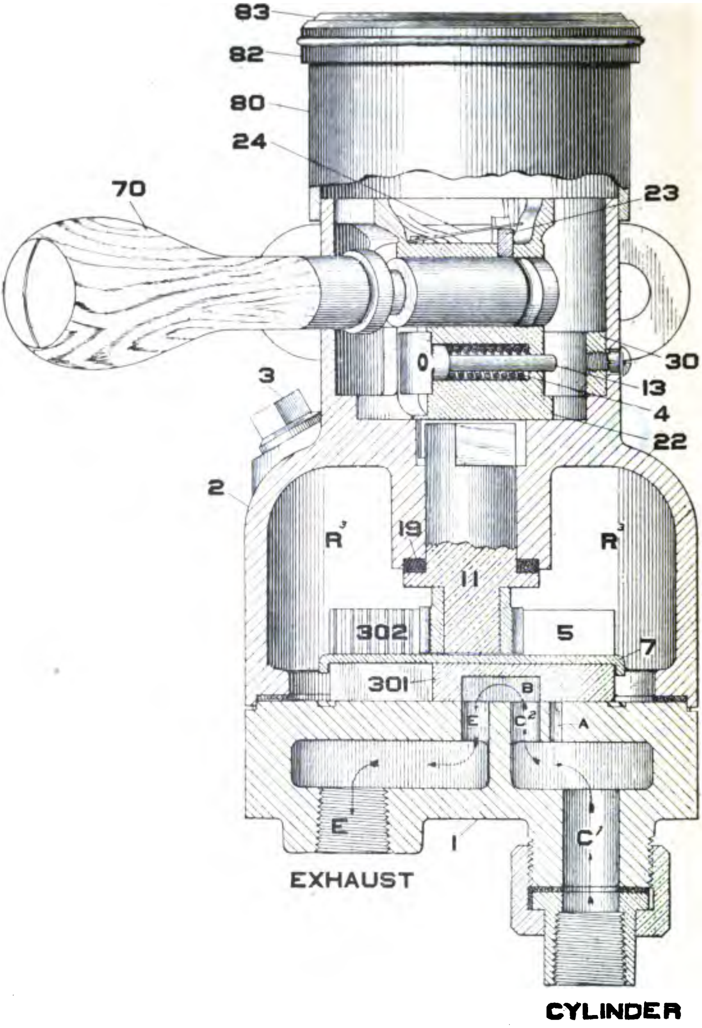
Straight Air Brake Equipments

WESTINGHOUSE TRACTION BRAKE CO.

26 Cortlandt Street,

New York, U. S. A.

FIGURE 1.



O. V. J. OPERATIVE VALVE.
View showing Slide Valve.

The Operating Valve—O. V. J.

The O. V. G. and O. V. J. Operating Valves are similar in construction, but have the position of their ports reversed, and consequently the movement of the handle of the O. V. G. is from release at the extreme right to emergency application at the extreme left, whereas with the O. V. J. the same movement occurs in the opposite direction. Otherwise their operation is identical.

Before describing the construction of the operating valves, a few words concerning the terms employed may be of advantage.

SLOW SERVICE APPLICATION—A gradual application of the brake, such as is usual in slowing up, preventing acceleration on grades, or making slow stops: it is made by admitting air pressure to the brake cylinder slowly through a small port; an ultimate pressure considerably less than the maximum is sufficient.

QUICK SERVICE APPLICATION—For a smooth and rapid stop, essential to the making of a fast schedule time. By opening the large port for an instant and then covering same, a high pressure in the brake cylinder is quickly attained, after which the pressure is gradually reduced as the speed decreases, thus making a smooth stop in the shortest distance practicable.

EMERGENCY APPLICATION—One in which the full braking power is applied almost instantaneously, for the purpose of avoiding collisions, saving lives, etc., obtained by fully opening the emergency port, thereby letting full reservoir pressure into the brake cylinder in the shortest possible time. The rail should always be sanded while making emergency stops to avoid possibility of sliding wheels and thereby making a poor stop.

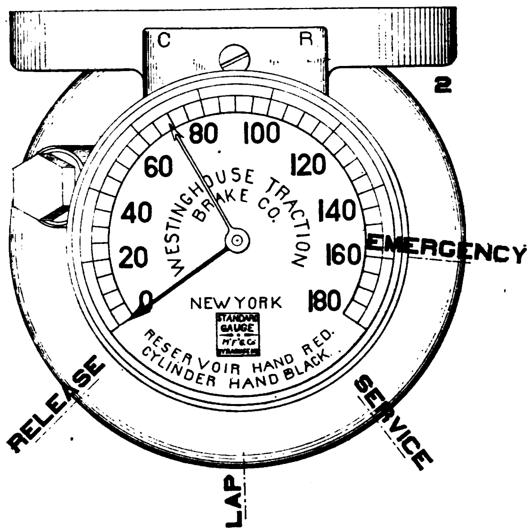


Fig. 2.

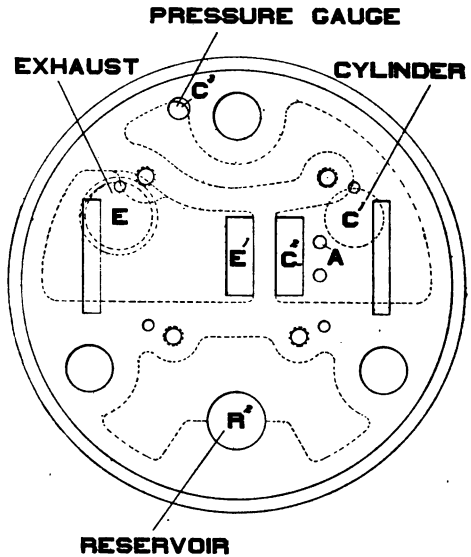


Fig. 3.

O. V. J. OPERATING VALVE.
Top View and Seat.

There are four positions of the O. V. J. valve (see Fig. 2, and small figures on pages 7 and 8).

Release—When the handle is at the extreme left, (the slide valve at the extreme right) and the cylinder and exhaust ports are connected, consequently atmospheric pressure only is in the cylinder, and the brakes are released.

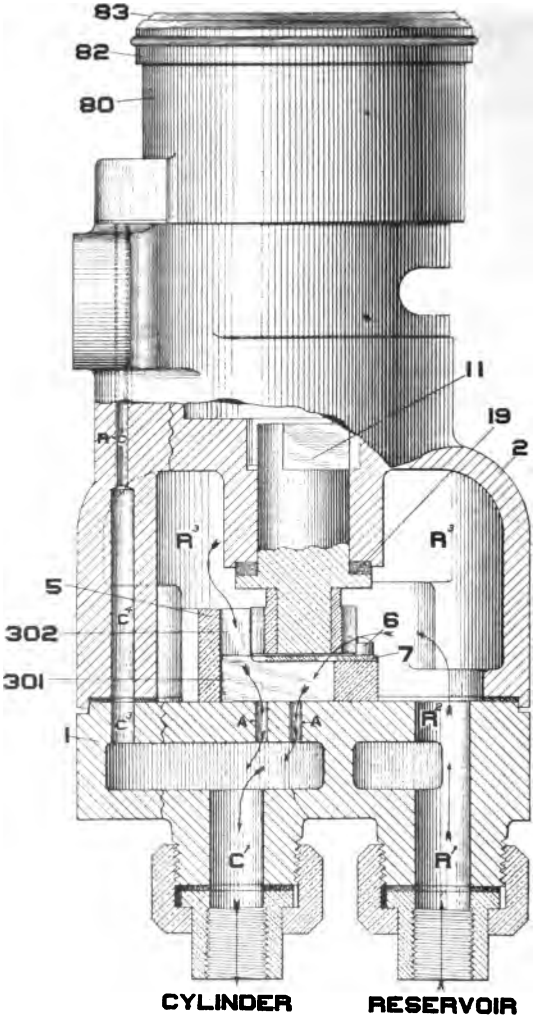
Lap—When the handle is about 45 degrees from release position and the ports leading to brake cylinder are closed, consequently the pressure conditions in the brake cylinder remain what they were previous to the moving of the handle to this position.

Slow Service Application—With the handle about 90 degrees from release, exhaust port closed, and the small port open to brake cylinder.

Emergency Application—With the handle at extreme right and both small and large ports wide open, exhaust port closed, brakes on with full power.

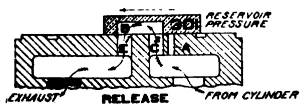
The **Operating Valve, Form O. V. J.,** shown in Figs. 1, 2, 3 and 4, consists of a head and body 2, cast in one piece. On the top of the head is a double gauge 80, of which the red hand indicates the reservoir pressure and the black one the pressure in the cylinder. The gauge is protected by heavy plate glass 83, secured in place by means of the ring 82, screwed on the gauge case. In the head, directly below the gauge, is a socket 22. Into this socket fits the removable handle 70, which swings through an arc of about 130 degrees when turning from release position at the extreme left to emergency at the right. The head is provided with a suitable slot to permit of this movement, but the handle may be withdrawn when the valve is in one position only, namely, "Lap." When withdrawn the latch 23 is dropped by

FIGURE 4.

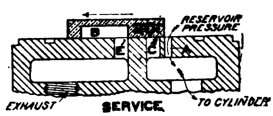


O. V. J. OPERATING VALVE.
View Showing Reservoir Cavity.

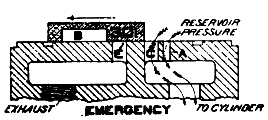
the spring 24 into suitable holes in the head, thus locking the socket in lap position until the handle is again inserted, when the latch is raised enough to disengage it again from the head. Just below the hole in the socket for the handle, is a smaller one, parallel to it, holding a spring actuated bolt 13, which, when the valve is operated, passes over suitable notches, thereby indicating the various positions of the valve. Engaging with the socket on its under side is a stem 11, provided with a pinion which engages with a rack 302 forming a part of the slide valve 301, so that when the handle is moved, the valve slides from side to side between suitable guides 5 and 6. The turned down ends of the spring plate 7 are not meant to serve as a stop for the travel of the valve, but simply as an indicator of the proper position of the valve when assembling. The handle must always be stopped by the ends of the slot and not by the valve striking the ends of the plate 7. The base 1 of the valve is provided with



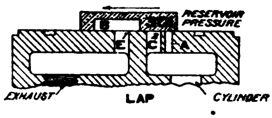
two rectangular ports (Fig. 3), the exhaust E to the left and the brake cylinder C to the right; when the handle is in release position at the extreme left these two ports are connected by means of the cavity B in the underside of valve, and the brake is fully released. The the right of the large brake cylinder port is a small one A leading to the same



cavity, which is uncovered first as the handle is moved to the position for a service application of the brake. A



further movement of the handle to the right uncovers the large port C also and the valve is in the position for an emergency ap-

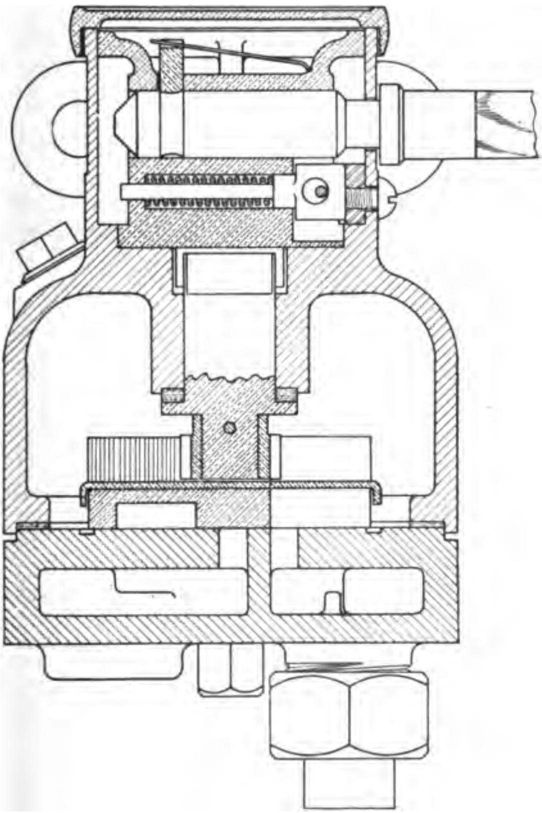


plication. Returning the handle to the left until the two cylinder ports are covered by the blank portion of the slide valve, puts it in the position of lap. The valve body 2 forms a chamber R^3 in constant communication with the reservoir by means of the $\frac{1}{2}''$ union connection on under side of base, at the right, Fig. 4. In the body of the valve are passages R and C, C^4 and C^3, which connect the reservoir chamber and the cylinder cavity in the base, to their respective gauges.

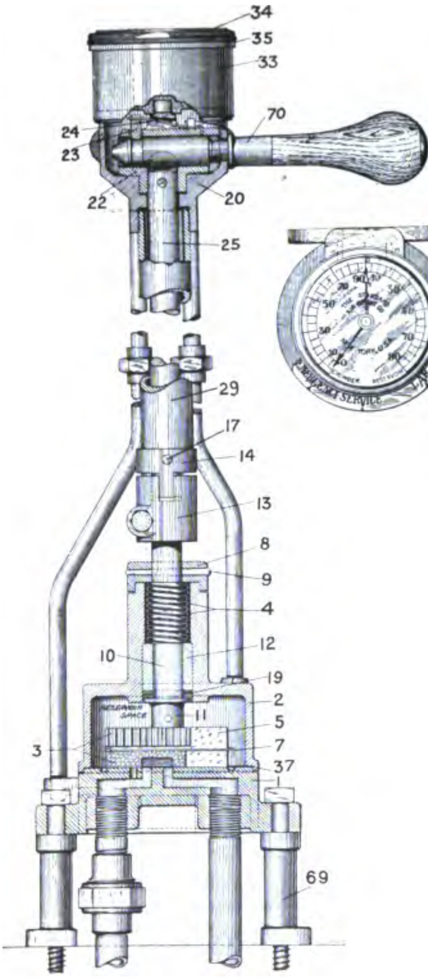
The Form O. V. P. Operating Valve.

The O. V. P. Operating Valve, Fig. 5, opposite page, is a modified form of the O. V. J. Valve, in which the air gauge is eliminated. It is for use in cases where it seems advisable to use a separate Air Gauge, mounted on the front wall of the vestibule, and connected to the piping system so as to show the brake cylinder and reservoir pressures. The operation of this valve is identical with the other, and the construction is very similar, but somewhat simplified by the absence of the gauge. That part of the O. V. J. Valve above the handle-socket cavity is entirely done away with, and is replaced by a brass plate which fits over the top of the casing as shown in Fig. 5.

FIGURE 5.



OPERATING VALVE, O. V. P.



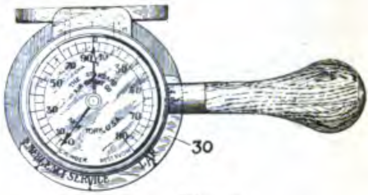


Fig. 7.

FIGURE 6.

OPERATING VALVE, O. V. T.

The Operating Valve, O. V. T.

The Operating Valve, Form O. V. T., shown in section in Fig. 6, and top view in Fig. 7, on the opposite page, is very similar to the form O. V. G., but has the valve part placed upon the floor of the platform with the operating head directly above it at the level of the motorman's hand. On the top of the head 20 is a duplex gauge 33, similar to that just described in the form O. V. J. The red hand of the gauge indicates reservoir pressure, and the black one train-pipe pressure. The construction of the gauge is exactly the same, it being protected by plate glass 34, secured in place by ring 35. The removable handle 70 engages in the socket 22, and swings through an arc of about 130° from release position at the extreme *right* to emergency position at the *left*. The handle may be inserted and withdrawn when in lap position only. The latch 23 actuated by spring 24 locks the socket in lap position when the handle is removed.

By means of a vertical shaft 25, enclosed in a pipe casing 29, and provided with flexible coupling 13 and 14, the socket in the head is connected to the stem 10 of the valve. The pinion 11 is secured to this stem and engages with a rack cut upon slide valve 3. The movement of the handle forces the slide valve from side to side between suitable guides in exactly the same manner as in the Form O. V. J.

The base 1 of the valve is provided with two rectangular ports similar to those shown in Fig. 3, but the release is to the right and the brake cylinder to the left. When the handle is in release position at the extreme right, these two are connected by means of the cavity in the underside of the slide valve, and the brake

is fully released. To the left of the large brake cylinder port is the small circular one leading to the same cavity, which is uncovered first as the handle is moved to the left from release position, and when it is fully opened the valve is in position for full service application of the brakes. A further movement of the handle to the left uncovers the large port also and the valve is in position for an emergency application. Returning the handle to the right until the two cylinder ports are covered by the blank portion of the slide valve, puts it in lap position when all ports are blanked. A further movement of the handle to the extreme right brings the valve to the position of release, as described above.

The flange 30 (see Fig. 7) attached to the head just below the slot for the handle is plainly marked for the positions of the handle corresponding to the different positions of the valve. The valve cover 2 forms a chamber, which is in constant communication with the reservoir. Near the cylinder connection, at the side of the base, is a lug having a $\frac{1}{8}''$ pipe-tapped hole leading to the cylinder cavity. This is piped to the hole in the head marked C, which leads to the black-hand gauge. The other $\frac{1}{8}''$ pipe-tapped hole in the head, marked R, is connected to the hole in the cover 2, which communicates to the cavity having reservoir pressure, thus bringing same to the red-hand gauge. A third hole, in this cover, is for the purpose of oiling the valve, which should be done regularly.

Instructions for Installation.

THE OPERATING VALVE O. V. J., should be secured to the vestibule framing or dash rail by means of a bracket and the lugs provided on the back of the valve for the purpose. It should be so located between the controller and the hand brake that the motorman may conveniently rest his hand on the handle when in "lap" or release positions, and be able to turn it through its entire range of movement without striking either the controller or brake staff. The gauge should be in full view of the motorman and not obscured by any part of the controller. The under side of the valve has three openings, two of which are provided with unions for $\frac{1}{2}''$ standard iron pipe. Connect the one in front to the reservoir pipe and the one in the rear (nearest to the side carrying the supporting lugs) to the train pipe, as shown in Fig. 2, Instruction Pamphlet No. T. 5001. The third opening, which has no union, is the exhaust, and should be connected to the Exhaust Muffler beneath the platform. If it is desirable to place a cock in the reservoir pipe so as to remove the operating valves without discharging the air pressure, one may be put in the branch pipe connecting the reservoir to the reservoir pipe; or two may be used, one in the reservoir pipe just below each operating valve, preferably inside the vestibule, but so placed that there will be no danger of its being closed by a broom when cleaning the car.

To install the OPERATING VALVE, FORM O. V. T., after finding proper location where the handle will be convenient for the motorman, and the platform sills will not interfere with the piping, bore three 1" holes through the floor to correspond with the tapped holes in the base as described on page 11, keeping, if possible, the cylinder

and exhaust openings in line across the car and toward the dash board. Connect the cylinder and reservoir outlets to their respective pipe lines by means of the unions supplied with the valve; the distance pieces 69, (Fig 6) support the valve at the proper height from the floor to admit of ready access to the unions. It will, however, be necessary to remove the distance pieces to get at the unions, and to take up the valve. By means of a short pipe, connect the muffler to the exhaust outlet, and fasten the base to the floor by means of two ⅜″ lag screws 5½″ to 6″ long. By means of an angle piece of ¼″ plate, secure the Operating Head to the dash rail or vestibule wall so that the staff is vertical, and be sure there is ⅛″ clearance between the end of the rod 25 and the top of the valve stem 10; while this is being done, the female clutch 13 should be loose on the valve stem. Then take hold of the spring cap 8 and turn the stem to the right gently until the valve 3 strikes the bent-over end of spring 7, which indicates the extreme travel in that direction; then return the stem 1/16″ (measured on the circumference of the spring cap) and with handle at extreme right, slip female coupling 13 up to within ⅛″ as far as it will go on male coupling 14 and clamp it securely on the valve stem by means of the cap screw. If, on turning the handle to the left, it will not go to the end of slot in the head, the valve is striking against the other end of spring 7, which shows that the stem was turned back more than the 1/16″ called for above and it should be reset. Make gauge connections with the ⅛″ pipe and unions as described on page 12.

Inspection and Maintenance.

The Operating Valve should be oiled regularly, eight or ten drops are sufficient. Should a leak develop inside the O. V. J. form near the handle socket, detach the body from the base and take out and soften the packing leather 19, Fig. 1. When replacing the body slide the valve to the extreme left, and with the handle at its extreme right, drop the body into place; before tightening the cap screws see that the handle swings readily the entire length of its slot. If the piping is properly cleaned so there is no grit to cut the seat, the valve will remain tight indefinitely.

If the O. V. T. form is used, note that the positions of the valve conform to those of the handle, as marked on the flange on the head; the handle should always move freely from one end of the slot to the other. In the event of the brake failing to operate, first look at the gauge to see if the pressure is still maintained in the reservoir; if the pressure is all right the trouble must be in the operating valve, or beyond; then try the brakes from the other end of the car; if they work all right the trouble is in the first operating valve tried: possibly the clutch has slipped.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .010

January, 1904

Instruction Pamphlet No. T 5008

Piping
for
Traction Brake Equipments

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

Piping.

STRAIGHT-AIR BRAKE EQUIPMENT.

The system of piping, as illustrated in Fig. 2, Instruction Pamphlet No. T 5001, may be divided into four parts, viz.:

(a) The Supply Pipe, which conveys the compressed air from the compressor to the reservoir.

(b) The Reservoir Pipe, which is simply a continuation of the reservoir up to the operating valves.

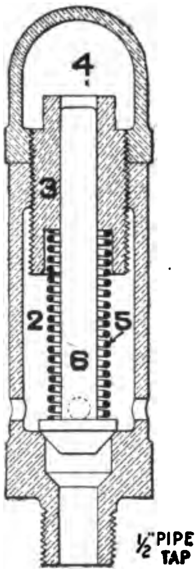
(c) The Train Pipe, which conveys the air pressure to the brake cylinders during an application of the brakes, and from the brake cylinders to the atmosphere during release.

(d) The Governor Pipe, which keeps reservoir pressure supplied to the pressure chamber of the governor.

The Supply Pipe connects the discharge opening of the compressor to the reservoir, and is always under reservoir pressure. In this pipe, at a point about two feet from the compressor, is placed a short length of hose to provide a flexible connection between the piping which is rigidly secured to the car, and the compressor which is subject to more or less vibration. This hose should be inclined as much as practicable that the oil discharged by the compressor may not be pocketed in it.

The Reservoir Pipe connects the reservoir with the operating valves and is also always under reservoir pressure. In it at a point near the reservoir is the Safety Valve, described later, which is set for a pressure slightly higher than that at which the governor is set to stop the compressor. Thus, if for any reason, the governor should fail to act, the pressure in the brake system may not be-

FIGURE 1.



SAFETY VALVE.

come excessive. In this pipe, cut-out cocks should also be placed where convenient of access, by means of which the reservoir may be cut off from the operating valves whenever it is necessary to examine or remove the latter.

The Train Pipe connects the operating valves to the brake cylinder. In this pipe, near the brake cylinder, a union should be connected. This union should be placed to one side of the cylinder, so that when the head is removed the piping will not obstruct the withdrawing of the piston. In cases where trailer cars are to be used, the train pipe has, at each end of the car, a cut-out cock and flexible hose coupling of the standard Westinghouse type, so that when reservoir pressure is admitted to the train pipe, it will be conveyed to both motor-car and trailer cylinders. These couplings are interchangeable with those used on steam railroads, unless a smaller size is specially ordered.

The Governor Pipe connects the reservoir to the compressor governor. In it, near the governor, is an insulating joint which effectively insulates the governor from the piping that might be grounded. A cut-out cock is also provided that the governor may be examined or removed without loss of air pressure, there being a union between them.

The exhaust port of the operating valve is connected by a pipe leading through the vestibule floor to an Exhaust Muffler underneath the platform. This muffler is a cylinderical chamber having a diameter several times that of the pipe, thereby forming a sudden enlargement of the passage, which dissipates the exhaust pressure and muffles the sound as the air escapes to the atmosphere.

Safety Valve.

The safety valve has a conical valve 6 (Fig. 1) held to its seat by a spring 5, the tension of which is adjusted by the regulating nut 3. When the pressure below the valve exceeds the force with which the spring holds it on its seat, it is raised and air escapes to the atmosphere through the holes in the spring case. This escape to the atmosphere will continue until the pressure in the piping system is reduced to an amount which will allow the spring to reseat the valve.

Installation of Piping.

STRAIGHT-AIR BRAKE EQUIPMENT.

The train pipe connecting the brake cylinder with the operating valves should be standard ½" pipe, unless very long, due to the use of trailers, when it should be ¾". For reservoir pipes, in most cases ½" is large enough, although, when convenient, it is best to use ¾" to reduce friction, insure prompt action, and increase the reservoir volume. Use ⅜" pipe for pump governor and whistle connections. All piping should be so arranged that there are no sags or pockets in which moisture may collect.

Wherever possible use long beds in the pipe rather than elbows. The friction due to a ½" elbow, with radius equal to five-eighths of its diameter, is equal to 4 feet of straight pipe. All pipe so bent must, however, be thoroughly blown out by steam or compressed air before it is put in place. The joints should be threaded with sharp dies and made up with either shellac or Japan varnish, putting it on the male thread only; never inside of the fittings. We do not recommend the use of red or white lead. If proper care is used, the piping is easily made bottle tight.

When all the piping has been completed, the maximum pressure should be pumped up in the reservoir with the operating-valve handles at the release position. The cocks in the reservoir pipe at the operating valves and governor should then be closed and the pipe disconnected at these points. The reservoir pipe should then be thoroughly blown out by opening these cocks, the piping having been previously sprung to one side to give free exit to the air. It would be well to exhaust a full tank of air through each one of these cocks. These joints should then be reconnected and the above cocks opened, while the pipe leading to the brake cylinder should be disconnected at the union placed near the cylinder. With both operating valve handles in release position, full pressure should be pumped up in the reservoir and discharged through this disconnected union by applying the brake in full emergency at *both operating valves simultaneously*. If only one valve were open at a time, chips might readily blow past the orifice of the branch leading to the brake cylinder and consequently not be discharged from the pipe. Having blown out the piping, pump up full pressure throughout the system and test every joint by applying soap suds. When all leaks have been stopped the piping must be securely clamped to the car to avoid vibration.

THE SAFETY VALVE should be screwed into a Tee in the reservoir line leading to the operating valve at a point near the reservoir. It must be placed vertically, and should not open until a pressure has been attained that is 10 pounds above that at which the governor should cut the compressor out of action.

Piping.

Automatic Air Brake Equipment.

The system of piping as illustrated in Fig. 1, Instruction Pamphlet T. 5010, gives the general arrangement as applied to this equipment, and is seen at a glance to differ very slightly from that for the Straight Air Brake Equipment, and may be divided into the same four parts.

The Supply Pipe connects the discharge opening of the compressor to the main reservoir, and should have installed in it about two feet from the compressor the short length of hose provided as a flexible connection between the compressor and reservoir.

The Reservoir Pipe connects the main reservoir with the brake valves, and is otherwise exactly similar to the equipment for the Straight Air; it should have cut-out cocks placed in it, by means of which the reservoir may be cut off from the brake valves whenever it is necessary to examine or remove the latter.

The Train Pipe, although connecting the brake valves to the brake cylinder, does so under somewhat different conditions, inasmuch as the train pipe in this equipment is usually under pressure. This pipe does not connect directly with the brake cylinder, but makes connection with the bottom part of the triple valve, and through it connects with either the brake cylinder or the auxiliary reservoir, depending on the position of the triple valve. As this equipment is generally applied to trains of two or more cars, it is almost always accompanied with flexible hose couplings for the train pipe at each end of the car for coupling up to other cars in a train.

The Governor Pipe connects the main reservoir to the compressor governor, and in it near the governor

should be placed an insulating joint and a cut-out cock with union, the former to insulate the governor from any part of the piping that might be grounded, and the latter to provide a means for examining or removing the governor without loss of pressure.

The exhaust opening of the brake valve should be connected by a pipe through the vestibule floor to an exhaust muffler underneath the platform. The muffler used is identical with that described in the Straight-Air Apparatus.

When a safety valve is used, it is applied to the piping in exactly the same manner and position as indicated above for the Straight-Air Apparatus, but relative to the main reservoir.

Installation of Piping.

Automatic Brake Equipment.

The train pipe connecting the triple valve with the brake valve is usually $\frac{3}{4}''$ standard pipe, although when the car is used with trains of considerable length it is advisable that it should be $1''$ pipe. The reservoir pipe is also usually $\frac{3}{4}''$, but when convenient we also recommend the use of $1''$ pipe to reduce friction, insure prompt action and increase the reservoir volume. For governor pipe and whistle connections use $\frac{3}{8}''$ standard pipe. All piping should be arranged so that there are no sags or pockets in which moisture may collect. The same care should be used in installing the piping as indicated in what was said above concerning the Straight Air Equipment.

If a Conductor's Valve is used, it should be placed on the end of the car inside, and high enough to be unnoticed by the passengers, but within reach of the conductor in case of emergency. It is a good plan to run

a special colored cord from the handle of this valve to each platform and so placed that it cannot be mistaken for the signal, or bell cord, and that the conductor can reach it from any point of the car. The $\frac{3}{4}''$ pipe to this valve should connect with the train pipe at its nearest point.

We also recommend a thorough cleaning and testing of the pipes after installation, as mentioned on page 6.

Axle-Driven Compressor Equipments.

The general directions given before in this pamphlet will apply to these equipments with equal force. It will only be necessary to modify the arrangement to include the different style of compressor. In this case the reservoir pipe is very short and made up, as a rule, in large part, by a flexible hose connection, as the compressor is located on the truck and the reservoir is generally fastened to the car framing.

The Regulator Pipe must, for the same reason, also have a flexible connection between the compressor and the regulator, otherwise the arrangement and method of installing the piping is practically the same, and no further description or instructions will be necessary.

Storage Air Brake Equipment.

The modifications of the piping necessary to adapt it to a Storage Air Brake System are as follows:

First, a high-pressure supply pipe, having charging-coupling fitting on each side of the car, should connect these two fittings together and to one of the two storage reservoirs. The two storage reservoirs should be connected together in series in such a manner that the air has to pass through both before reaching the brake sys-

tem, therefore the high-pressure supply pipe should enter one end of the first storage reservoir; the opposite end of this storage reservoir, and the similar end of the second storage reservoir should be connected by piping of the same size. The remaining end of the second storage reservoir should be connected directly to the reducing valve, which should be placed so as to feed the air directly into the service reservoir.

The reservoir pipe connects the service reservoir with the operating valve, and in it, near the service reservoir, should be placed the safety valve, which should be set to open at 10 pounds above the pressure to which the reducing valve is adjusted.

The train pipe is the same as in the ordinary Straight Air Brake Apparatus.

The governor pipe is replaced in this set by the high-pressure gauge pipe, which connects the second storage reservoir with a high-pressure gauge placed near the operating valves in full view of the motorman.

The high-pressure supply pipe is usually 1″, also the pipe connecting the storage reservoirs and that connecting the second storage reservoirs with the reducing valve. The reservoir pipe and train pipe are usually standard ½″ pipe, and the high-pressure gauge pipe ⅜″ standard pipe.

Westinghouse Traction Brake Company

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"
Telephone, 6950 Cortlandt
Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 011

January, 1904

Instruction Pamphlet No. T 5009

Type D Chime-Whistle Set

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

The Chime-Whistle Set.

STRAIGHT AIR-BRAKE EQUIPMENT.

The Whistle Set consists of a Chime Whistle, a Whistle Valve, and a Special Cut-out Cock.

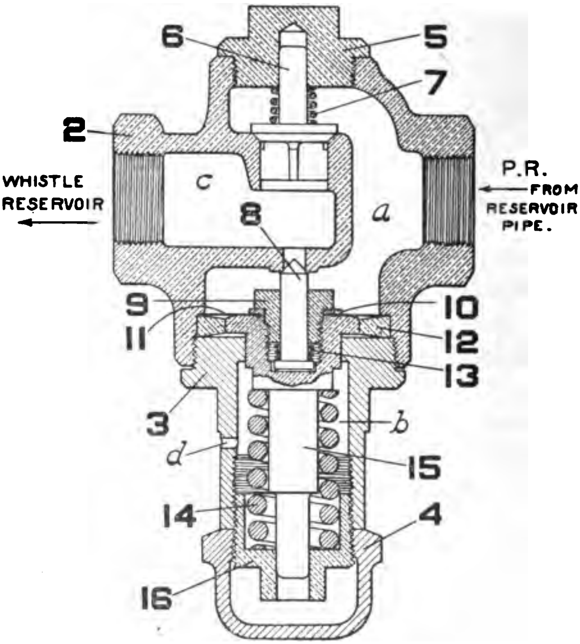
The Whistle Valve is of the globe pattern, having its valve held on its seat by a spring supplemented by the air pressure, the stem of the valve passing through the body and engaging with a lever to which the whistle cord is attached. When the cord is pulled, the stem is pushed in by the lever, thereby compressing the spring and unseating the valve which allows air to flow to the whistle. When the cord is released, the spring under the valve, assisted by the air pressure, forces the valve to its seat, and shuts off the supply of air.

The Cut-out Cock is placed in the whistle pipe so as to cut off the supply of air to the whistle set, whenever necessary.

In case of a car equipped with controlling apparatus at both ends, there should be a set of whistle apparatus as above described, at each end of the car.

We recommend the installing also of a special whistle reservoir and duplex check valve, although these are not ordinarily included in this set when the Straight Air Brake Equipment is used. Inasmuch as the whistle reservoir constitutes a special supply for the whistle at all times without drawing on the main reservoir supply, and the duplex check valve prevents the drawing off of air from the main reservoir when the pressure in the latter is low, the brake system itself is protected from an unnecessary waste of air through the whistle; also through the duplex check valve, the whistle reservoir is made a part

FIGURE I.



DUPLEX CHECK VALVE.

of the latter, thereby increasing its volume quite materially. A description of the duplex check valve and its operation will be found below.

With Automatic Brake Equipment.

Besides the three items included in this set as just described, the following are required with the Automatic Equipment

A 12" x 33" Whistle Reservoir.

A Duplex Check Valve, with feed spring set at three pounds below cutting in pressure of the compressor governor.

The Whistle Pipe is, in this case, connected to the Whistle Reservoir and not to the Reservoir Pipe. In the connection between the whistle reservoir and the reservoir pipe is placed the Duplex Check Valve, with its inlet marked "P. R." connected toward the reservoir pipe.

The Duplex Check Valve is shown in Fig 1, on opposite page. Air coming from the reservoir pipe through the inlet "P. R." enters chamber *a* and thus acts upon the upper side of diaphragm 11. The chamber *b*, below the diaphragm, is connected to the atmosphere through the small hole *d*, in the spring case 3. The spindle 15 is secured to the diaphragm by nut 9 and washer 10. Spring 14 is adjusted by nut 16 to a pressure three pounds below that at which the compressor governor is set to cut the compressor into action—normally 77 pounds. When the air pressure in *a* is greater than that amount, diaphragm 11 and spindle 15 are forced down, unseating the plug valve 8 and allowing air to flow into *c* and so to the whistle reservoir. If, for any reason, the main reservoir pressure falls below the amount above stated, spring 14 forces diaphragm 11

up again and plug valve 8 is seated, thereby cutting off any further supply to the whistle system till the main reservoir pressure is above 77 pounds. It will be noted, however, that check valve 6 permits air to flow from the whistle reservoir to the main reservoir whenever the pressure in the latter falls slightly below that of the former, thereby making the whistle reservoir a part of the main reservoir and increasing the volume of the latter by a considerable amount. Check valve 6 is forced onto its seat by small spring 7 as soon as air ceases to flow from the whistle reservoir into the main reservoir pipe.

It is readily seen that the object of the Duplex Check Valve is to make it impossible for the motorman, by too frequent and prolonged use of the whistle, to reduce the main reservoir pressure to a point where it might fail to release the brakes after an application; also to convert the whistle reservoir into a part of the main reservoir supply system.

On a car operated from both ends, both whistles are piped to the whistle reservoir, as shown in Instruction Pamphlet No. T. 5010, the whistle pipe entering at the end opposite to that at which the connection from the reservoir pipe and duplex check valve is made.

Installation of the Whistle Set.

Wherever possible, the whistle should be placed just above the roof of the motorman's cab and connected by a ½″ pipe to the whistle valve. The latter should be placed inside the cab and as close to the whistle as practicable. The valve must be so placed that the pressure of the air tends to close it. With the Straight-Air Equipment, connect the whistle valve to the reservoir pipe at

the nearest point with $\frac{3}{8}''$ pipe, interposing the $\frac{3}{8}''$ cut-out cock at a convenient location, preferably inside the cab. A cord may be run from the end of the whistle-valve lever across the cab with such an amount of slack that it comes within easy reach of the motorman.

On open cars the whistle may be placed below the platform and operated by means of a wire attached to the lever handle and brought up through the floor. We do not recommend the operating of the whistle with the foot, as it invariably leads to a waste of air.

In connection with the Automatic Equipment the Whistle-pipe should be connected to the 12" x 33" Whistle Reservoir instead of to the Reservoir-pipe.

The Whistle Reservoir should be suspended from the car flooring similarly to the main reservoir, and at any convenient location. The $\frac{3}{8}''$ pipe to the Whistle should be connected at one end, and the branch pipe from the main reservoir pipe at the other.

The Duplex Check Valve should be placed in the connection between the Whistle Reservoir and the main reservoir pipe with it's inlet marked "P. R." towards the reservoir pipe. The Safety Valve, which is in the reservoir pipe should never be placed on the Whistle Reservoir side of the Duplex Check Valve, or in any part of the Whistle pipe either on the platform or under the car.

Westinghouse Traction Brake Company

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"
Telephone, 6950 Cortlandt
Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .012

January, 1904

Instruction Pamphlet No. T 5010

The Automatic Traction Brake with Motor-Driven Compressor

26 Cortlandt Street,
New York, U. S. A.

The Westinghouse Automatic Traction Brake with Motor-Driven Compressor.

The essential difference between the Automatic and Straight-Air Traction Brake systems is that in the latter air is admitted to the train pipe to apply the brakes and allowed to escape from it to release them; whereas, in the Automatic, air is allowed to escape from the train pipe in order to apply the brakes, and is admitted to it again to release them. With the Straight-Air equipment the train pipe is never under pressure except during an application of the brakes, whereas the Automatic train pipe is under pressure, except in emergency applications, and this pressure is greatest when the brakes are released.

Also each brake cylinder in the Automatic system is provided with its own reservoir, called the Auxiliary Reservoir, in which air is stored for use in this cylinder only. The reservoir which receives the compressed air directly from the compressor is, in this case, called the Main Reservoir, and furnishes the air to charge the train pipe and auxiliary reservoirs, and release the brakes.

The connection between each brake cylinder and its auxiliary reservoir and the train pipe is made through a Triple Valve in a manner to be explained presently.

Fig. 1 shows the general arrangement of the Automatic Equipment, and it will be noted that it is comprised of the following parts:

First—An Air Compressor actuated by an independent electric motor, which supplies the compressed air.

Second—A Compressor Governor which automat-

ically controls the operation of the Compressor, thereby maintaing the pressure and regulating the supply of compressed air.

Third—A system of wiring, including Switches and Fuse Box, which connects the main trolley circuit to the Compressor and Governor.

Fourth—A Reservoir in which the compressed air is stored.

Fifth—A Brake Cylinder, the piston rod of which is connected to the brake levers in such a manner that, when the piston is forced outward by air pressure, the brakes are applied.

Sixth—A Motormon's Brake Valve, which regulates the flow of air from the main reservoir into the train pipe for charging the auxiliary reservoirs and releasing the brakes, and from the train pipe into the atmosphere for applying the brakes.

Seventh—A Duplex Air Gauge, which shows simultaneously the pressure in the main reservoir and in the train pipe.

Eighth—An Auxiliary Reservoir, which is supplied with air from the main reservoir, through the train pipe and triple valve, and stores it for use upon its own vehicle.

Ninth—A Quick Action Triple Valve, which is suitably connected with the train pipe, auxiliary reservoir and brake cylinder, and which operates by variations of the air pressure in the train pipe, (1) to admit air from the auxiliary reservoir (and, when required, as will be explained hereafter, from the train pipe) to the brake cylinder, thereby applying the brakes, and at the same time to cut off communication from the train pipe to the auxiliary reservoir, and (2) to restore

communication between the train pipe and the auxiliary reservoir, and at the same time to discharge the air from the brake cylinder to the atmosphere, thereby releasing the brakes.

Tenth—A system of piping, which, with various small fittings, forms the connections between the above mentioned parts, and when trailers are used includes flexible hose and couplings between cars.

Eleventh—A Safety Valve placed in the air supply system to prevent any possibility of accumulating an excessive pressure.

Twelfth—Also often specified is a Chime-Whistle Set, operated by air pressure, as a warning of approach, in place of a gong or bell.

Fig. 1 diagrammatically illustrates the essential parts of the automatic brake system and their relative location, as usually applied to trains of two or more cars.

The operations of the brake are controlled by the triple valve, the primary parts of which are a piston and slide valve. A moderate reduction of air pressure in the train pipe causes the greater pressure remaining stored in the auxiliary reservoir to force the piston and its slide valve to a position which allows the air in the auxiliary reservoir to pass into the brake cylinder and apply the brake; a sudden or violent reduction of the air in the train pipe produces the same effect, but, in addition (if a quick-action triple valve), it causes supplemental valves to be opened, permitting the air from the train pipe to also enter the brake cylinder, thereby producing a brake-cylinder pressure about 20 per cent. greater than that derived from the auxiliary reservoir alone and producing a practically instantaneous application of the brakes throughout the train. When the

pressure in the train pipe is subsequently increased above that remaining in the auxiliary reservoir, the piston and slide valve are forced in the opposite direction to their normal positions, thereby restoring communication between the train pipe and the auxiliary reservoir and permitting the air in the brake cylinder to escape to the atmosphere through the triple-valve exhaust port, thus releasing the brakes, and at the same time recharging the auxiliary reservoirs.

When the motorman wishes to apply the brakes, he moves the handle of the motorman's brake valve to the right, which cuts off communication with the main reservoir and permits a portion of the air in the train pipe to escape; to release the brakes, he moves the handle to the extreme left, which allows air to flow from the main reservoir into the train pipe, restoring the pressure therein.

A device called the Conductor's Valve may be placed on each car, to which is attached a cord that runs throughout the length of the car. In case of accident, by pulling this cord, the valve is opened and discharges air from the train pipe, applying the brakes. When the train has been brought to a full stop in this manner, the valve must be closed.

Should a train break in two, the escape of the air in the train pipe applies the brakes automatically to both sections. The brakes are also automatically applied through the bursting of a hose or pipe. In fact, *any material reduction of pressure in the train pipe applies the brakes,* which is the characteristic feature of the Automatic Brake.

An angle cock is placed in the train pipe at each end of every car, which must be closed before separat-

ing the couplings, to prevent an application of the brakes. A cut-out cock is also placed in the cross-over pipe leading from the train pipe to the quick-action triple valve, and also in the train pipe near the motorman's brake valve, within convenient reach of the motorman. The former is for the purpose of cutting out, or rendering inoperative, the brake apparatus upon a car, if it should become disabled for any reason, and the latter is for cutting out the motorman's brake valve upon all motor-cars except the first, in case two or more are attached to the same train.

Installing the Motor-Driven Compressor Automatic Brake Equipment.

Fig. 1 shows the relative arrangement of the various pieces of apparatus which comprise our Motor-Driven Compressor Automatic Brake Equipment. This is the result of careful study and long experience, and we earnestly recommend that the parts of this equipment be connected in the same relative order as shown in the cut. In figuring out the best possible locations for the compressor, brake cylinder, and reservoir, due regard must be had to the electrical apparatus already under the car, or to be placed there, as well as to the fact that those parts requiring inspection and care should be placed in the most accessible locations to facilitate inspection and maintenance.

After these locations have been settled upon, we recommend that the apparatus be installed according to the instruction given in the Instruction Pamphlets mentioned on page 14 of this pamphlet.

The Handling of Automatic Brakes in Service.

After making up a train the brakes should always be tested in the following manner: With the brake-valve handle in the running position, charge the train line and auxiliary reservoirs; to determine when the charging is complete, place the brake-valve handle in lap position and when everything is charged, the black hand of the duplex gauge will not fall. The motorman will then apply the brakes by moving the handle of the brake valve to the service application notch until a reduction of ten pounds has been made in the train line. Then, after placing the brake valve on lap, the motorman should remove the handle, and, carrying same with him, proceed along the length of the train and see that the cylinder piston of every car has moved out such a distance as to indicate that the brakes are properly applied on all cars of the train. He should then release the brakes from the last cab at the rear end; then again remove the handle and return to the front end, examining all cylinder pistons. He should be careful to see that they have moved back to full release, thus indicating that all brake shoes hang free.

For any purpose except testing brakes or making an emergency application, the first reduction in train-line pressure should be from five to seven pounds; a smaller reduction might not be sufficient to force the brake piston past the leakage groove in the cylinder, and more than seven pounds will cause too severe an application of the brake at the first reduction, and is liable to give a shock to the train. After the first five to seven-pound reduction, the best results are obtained by not using more than three or four pounds at any one reduction; this, however, must be governed entirely by the circumstances.

As from thirteen to fifteen pounds reduction in train-line pressure causes an equalization of auxiliary-reservoir and brake-cylinder pressures, when making a service application, thus fully applying the brake, a further reduction in train line is simply a waste of air. The results of such a waste are that the brakes are slower in releasing, fail to release simultaneously, cause shocks to the train upon stopping, and seriously overtax the compressor.

In making the ordinary service stop, two applications should generally be made. By this we mean that from the time the brakes are applied until they are released, no matter how many reductions are made, is one application; after the brakes have been released and are reapplied, is the second application. The use of two applications instead of one in making a service stop is better because this method of handling the brakes, quickly brings the train down from a high to a low speed, is a safeguard against skidding of wheels, insures greater accuracy in making stops and permits the train to be brought to a standstill with a light reduction of pressure on the second application.

In releasing the brakes after making an application in a service stop with the intention of immediately making a second application, the brake-valve handle should be moved to the full release and at once returned to the lap position. The reason for this is that if the brake valve is left in full release position, the train pipe will at once build up to seventy-pounds pressure, whereas the feed grooves in the triple valves are small and require considerable time to bring up the pressure in the auxiliary reservoirs to that in the train pipe; consequently, if only a few seconds elapse between the release and the following desired application, the train pipe pressure will be

greatly in excess of that in the auxiliary reservoirs. When this condition exists, the train pipe is said to be "overcharged." But by moving the brake-valve handle as above directed, the sudden wave of air throughout the train effectively releases the brakes, but does not raise the train-pipe pressure greatly above that in the auxiliary reservoirs, and overcharging is avoided. An overcharged train pipe has the following effect when another application is attempted shortly after a release: In order to apply the brakes, the train-pipe pressure must be reduced lower than the auxiliary-reservoir pressure; if the two are kept as nearly equal as possible when releasing, the second application can be obtained immediately; but if the train-pipe pressure is much higher than the auxiliary-reservoir pressure, then such higher pressure must be exhausted first to get them equal, and a further reduction made to reduce train-pipe below auxiliary pressure,—all of which consumes time and results in the train moving to a point beyond the intended stop.

In making ordinary station stops, a partial release of the brakes should be made at a sufficient time before the train comes to a standstill to avoid the backward lurch. The application of the brakes should be performed as just explained for making a service stop, as sometimes the brakes release slightly too soon and the train continues to drift very slowly, but by moving the brake-valve handle to the lap position, the brakes will again respond to a very light reduction, bringing the train to a standstill with little or no shock, even when held on until the train comes to a stop. Immediately upon the train coming to a standstill, move the handle to full release position until the train line is charged to maximum pressure, then bring it back to running position. This also

applies at all other times when the brakes have been applied and full release is desired.

In making full release of the brakes, the brake-valve handle should invariably be moved to the full-release position; by so doing a strong wave of air flows through the train pipe, insuring the release of all brakes simultaneously, whereas, with the brake valve in running position, the train line feeds up very slowly and if any triple-valve pistons have leaky rings, the air may get by the piston and feed up the auxiliary reservoir to full pressure without forcing the triple-valve piston to the release position. Thus the brakes would not release on such cars, and it would be impossible to release them without bleading down the auxiliary-reservoir pressure through the release valve under the car.

If the brakes release after a service application, examine all the brake valves in the train until the trouble is located. Either a brake valve has not been fully lapped or has a rotary valve leaking.

In case of emergency when it is essential to stop the train in the shortest possible distance, the handle should be thrown to the full emergency position and left there until the train has come to a stop, or the danger is passed. Do not attempt to save some of the train-line pressure by returning the brake-valve handle to lap position after making a quick reduction, but leave it in emergency position. If the motorman has the brake partially applied in service application, and should be suddenly flagged, he should put the valve handle in the emergency position and leave it there until stopped; whether or not quick action would be obtained under these circumstances would depend on the amount of reduction made in service, and the length of the piston travel. With only a light

reduction he would get partial quick action, but would not get full quick-action brake-cylinder pressure. Nothing could be gained by placing the handle in release position for a moment before going to emergency position; in fact it would be dangerous to do so. Such an action would release the brakes when they were most needed, would make them slower to apply by overcharging the train pipe, and when applied they would be even weaker than a full service application would have been at the start. If the motorman had the brakes applied with a thirteen to fifteen-pound service application and an emergency arose, he should put the brake-valve handle in the emergency position; possibly some of the brakes have partly leaked off, or have long piston travel, and the emergency application would set them fully. As a last resort to prevent collision or to save life, a motorman may reverse the motors. The reverse handle should be thrown into opposite direction and the controller handle moved to the second notch, which notch is usually found to have the greatest retarding effect. Motors may also be reversed in the event of the brakes being inoperative, but in ordinary service conditions motormen must never reverse the motors.

In case the brakes apply suddenly without apparent cause, the motorman should place the brake-valve handle in lap position until a signal is given to release the brakes. This prevents the escape of main reservoir pressure, thereby providing for a prompt release of the brakes.

When necessary to operate the conductor's valve it should be pulled wide open and allowed to remain, or be held, in that position until the train stops, and then before leaving it the valve should be closed. This valve must be kept open until the train has stopped, because if

it is closed and the motorman fails to place the brake valve in lap position, the brakes will release.

A bursted train-line hose or train pipe, or the breaking in two of the train, will apply the brakes; in the event of a burst in the train-line hose or pipe, close the train-pipe cock immediately ahead of the break and release the brakes to the rear of it by opening the release valves in the auxiliary reservoirs. The brakes ahead of the closed train-pipe cock can be released by the motorman and operated to handle the train until the fractured hose can be replaced.

In the event of the main-reservoir hose bursting, close the reservoir-pipe cock immediately ahead of and behind the disabled hose, and cut out all the pump switches behind same.

Should the cross-over pipe connecting the train pipe and triple valve be broken, if the break is between the cut-out cock and the triple valve, the cut-out cock should be closed and the release valve under the disabled car opened. If the pipe is broken between the cut-out cock and the train pipe, the train-pipe cock on the front end of the disabled car should be closed, the release valves in all auxiliary reservoirs behind the disabled car, as well as on that car, should be opened, and the brakes ahead operated the same as with a bursted hose.

To properly operate a release valve it should be held open only until the exhaust air commences to escape from the triple valve, and should then be closed. If it is held open longer, it results in a waste of air and has a tendency to set the other brakes.

Brakes should be cut out on cars only when they are in such a condition as to render it impossible to operate

them on such cars; small leaks are not sufficient cause for cutting out cars.

In setting off cars the train-pipe cocks should be closed first and the hose parted by hand and hung up properly; never leave the hose to be jerked apart by the separating of the cars. Before setting the hand brake on the set-off car make sure that the air brake has been released. The foundation brake rigging of some cars is so constructed that the hand and power brakes pull against each other, in which case if the hand brake is set up with the air brake applied, the leaking off of the latter would release the brakes.

The following Instruction Pamphlets added to this one go to make up a complete set as applied to the Automatic Brake equipment with Motor-Driven Compressor:

Motor-Driven Compressor........................	No. T 5002
Motor-Compressor Governor, Form E...........	T 5003
Wiring..	T 5004
Reservoirs....................................	T 5005
Brake Cylinder................................	T 5006
Motorman's Brake Valve........................	T 5011
Quick-Action Triple Valve.....................	T 5012
Piping..	T 5008
Chime-Whistle Set..............................	T 5009

Westinghouse Traction Brake Company

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 013

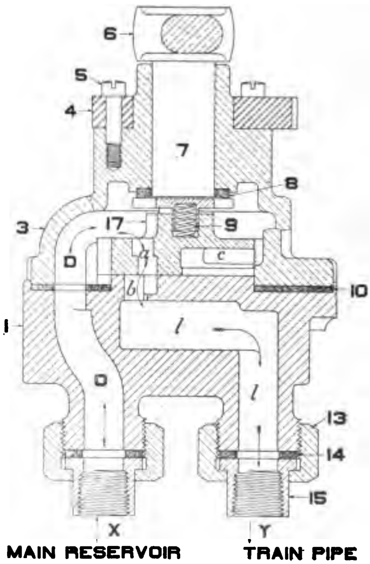
January, 1904

Instruction Pamphlet No. T 5011

The Motorman's Brake Valve
with
Slide-Valve Feed Valve

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

FIGURE I.



MOTORMAN'S BRAKE VALVE.

The Motorman's Brake Valve.

Before describing the operation of the Motorman's Brake Valve, it is advantageous to explain a few commonly used terms, which are as follows:

EXCESS PRESSURE—The difference between the pressure in the main reservoir and that in the train pipe; this, when the train brake apparatus is fully charged, is usually from 20 to 30 pounds. Excess pressure combines with abundant main-reservoir capacity to insure prompt release and recharging. The amount of excess pressure to be carried is determined by the character of the road, length of train, size of main reservoir, and kindred considerations.

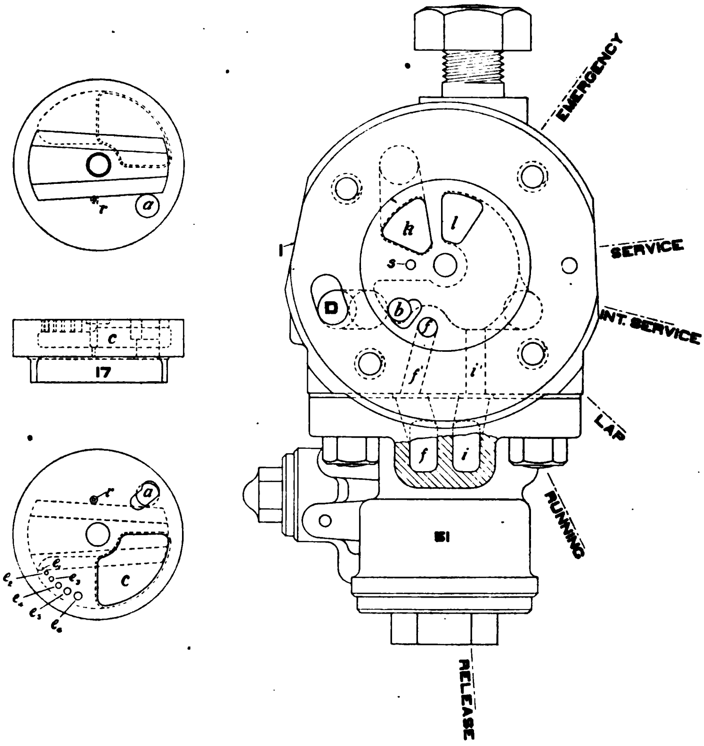
SERVICE APPLICATION—A gradual application of the brakes, such as is usual in slowing up or in a regular stop; a gradual reduction of train pipe pressure produces this effect.

EMERGENCY APPLICATION—Is one in which the full braking power is applied almost instantaneously, for the purpose of avoiding a collision, saving lives, etc.; a sudden reduction of train pipe pressure produces this effect.

The red-hand gauge connection of the Duplex Gauge is connected to the reservoir pipe, and indicates main-reservoir pressure. The black-hand connection is directly connected to the train pipe, and indicates train pipe pressure. The black hand is usually referred to as the train pipe-pressure hand, and the red as the main reservoir-pressure hand.

The customary standard train pipe pressure is 70 pounds, while 90 pounds is quite general as a standard main reservoir pressure; but these pressures may

FIGURE 2.



MOTORMAN'S BRAKE VALVE.

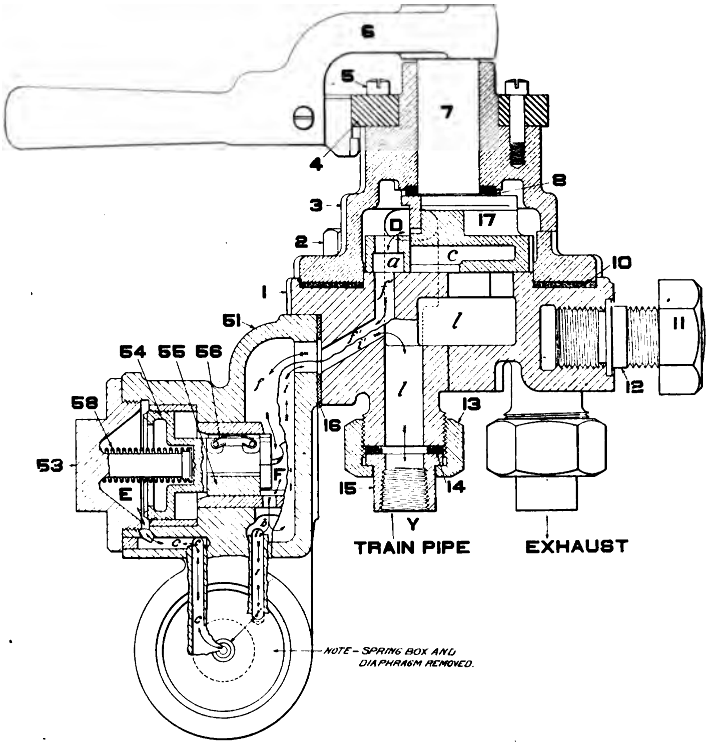
be modified to meet special conditons. In this book, 70 pounds will be considered the standard train pipe, and 90 pounds the standard main reservoir pressure; but it should be understood that, in special cases, it is proper to modify this practice.

There are six different positions of the Motorman's Brake-Valve handle; namely, Release, Running, Lap, Intermediate Service Application, Service Application and Emergency Application Positions. As the motorman faces the valve, the position farthest to his left is Release, and the other positions follow to the right in the order named.

RELEASE POSITION—The purpose of this position is to provide a large and direct passage from the main reservoir to the train pipe, to permit a rapid flow of air into the latter, to insure a quick release and recharging of the brakes. Release is the position shown in Fig 1. The reservoir pipe leads from the main reservoir to the Brake Valve, and is connected at X; when the Brake Valve is in Release Position, main-reservoir air flows through passage D, to the chamber above rotary valve 17, thence through port *a* in that valve, cavity *b* in its seat 1, and passage *l*, *l'* to the train pipe at Y.

While the handle of the Brake Valve is in Release Position, "warning port" *r* (Fig. 2), of very small area, registers with port *s* in valve seat 1, and discharges main-reservoir pressure to the atmosphere with considerable noise, attracting the motorman's attention if he subsequently neglects to move the valve handle to Running Position. If the Brake Valve were allowed to remain in Release Position, a pressure of 90 pounds would result, not only in the main reservoir, but also in the train pipe

FIGURE 3.



MOTORMAN'S BRAKE VALVE.

and auxiliary reservoirs, since, in this position, they are all in direct communication. To stop the escape of air through the "warning port" and to prevent overchanging the brake system, the valve handle is moved to Running Position.

Running Position—This is the proper position of the Brake Valve when the brake apparatus is charged and ready for an application. In this position (shown in Fig. 3), the main-reservoir pressure attains the proper excess above that in the trainpipe. Main-reservoir air, which is always present in the chamber above rotary valve 17, is conducted by port *a* in that valve and passages *f* and f^1 into chamber F; thence, as hereafter explained, its course is through the Feed Valve, from which it is conducted by passages *i*, *l* and *l* into the train pipe at Y. The Feed Valve is adjusted to cut off the air supply to the train pipe when the pressure reaches 70 pounds, so that charging then ceases, though the compressor governor will not stop the compressor until main-reservoir pressure has reached 90 pounds.

The operation of the Feed Valve is described hereafter.

Lap Position—This position, the second from Release, is that in which all ports are operatively blanked. After the preliminary discharge of air for a service application of the brakes, the valve handle is placed in this position until it is desired to make a further train pipe reduction or to release the brakes. If the compressor be started with the Brake Valve "on lap," the result will be a pressure of 90 pounds in the main reservoir and no pressure in the train pipe, when the compressor is stopped by the Governor.

Intermediate Service Application Position—

This position is the third from Release, and corresponds to the "Slow Service Application" of the straight air operating valve. It is used to cause a gradual application of the brake, such as is usual in slowing up, preventing acceleration on grades, or making slow stops. When in this position, service exhaust ports e^1, e^2 and e^3 (Fig. 2), in the lower face of rotary valve 17, register with port *k* in the valve seat, while a portion of cavity *c* in the rotary valve is over cavity *l* in the valve seat, thereby allowing air to flow from the train pipe through *l*, *l*, *c* and the service exhaust ports e_1, e_2 and e_3 to *k*, and through the exhaust pipe, to the atmosphere. It should be noted that the service exhaust ports are so placed and spaced as to form a gradually increasing opening from the train pipe to the atmosphere as the handle of the brake valve is turned from lap to service position. This is essential to a service stop.

Service Application Position—This is the fourth from Release, and corresponds to the "Quick Service Application" of the straight air operating valve. It is used for a smooth and rapid stop, essential to the making of a fast schedule time. In this position, the service exhaust ports e_1 to e_6, inclusive, are all in communication with port *k*, thereby causing a more rapid flow of air from the train pipe through *l*, *l*, *c*, the service exhaust ports and *k* to the atmosphere, and a consequent more rapid stop.

In any Service Application, when the desired reduction in the train pipe pressure has been secured, the handle of the rotary valve is moved back to Lap Position. Ordinarily a reduction of from 5 to 8 pounds in train pipe pressure is sufficient for an initial application of the brakes.

Emergency Application Position—This position,

which is the farthest from Release, is used for an emergency application of the brakes. Exhaust-port *k* and supply-port *l* (Fig. 2) are directly connected by means of large cavity *c* in rotary valve 17, which, in this position, overlaps both, thus permitting a very rapid discharge of train pipe air through large ports. The resulting sudden reduction of train pipe pressure causes the nearly instantaneous application of the brakes throughout the train, as already described.

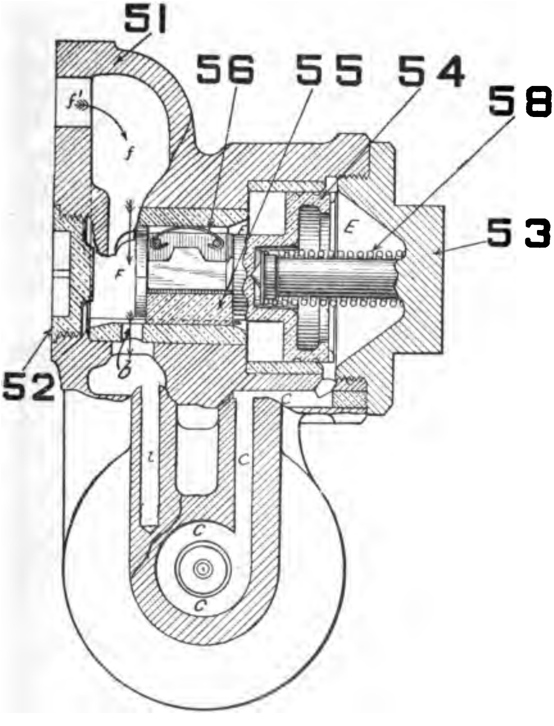
INSTALLATION.

The Motorman's Brake Valve should be secured to the vestibule framing or dash rail by means of a bracket for the stud and nut provided on the back of the valve for the purpose. It should be so located between the controller and the hand brake that the motorman may conveniently rest his hand on the handle when in "lap" or "release" positions, and be able to turn it through its entire range of movement without striking either the controller or brake-staff. The Duplex Air Gauge should be fastened to the vestibule framing in such a manner as to be in front of and at nearly an equal height with the motorman's eyes when he is standing at his post. Tees should be placed just below the brake valve in the main reservoir pipe and train pipe, with reducers for ¼″ pipe. The red hand of the Duplex Air Gauge should be connected to the tee in the main reservoir pipe, and the black hand to that in the train pipe. The pipes used for these connections we recommend to be ¼″ *copper* pipes.

The under side of the valve has three openings provided with unions for ½″ standard iron pipe. Connect

the one on the left in front to the main-reservoir pipe, and the one on the right in front to the train pipe. The third opening, in the rear (nearest to the side carrying the supporting stud), is the exhaust, and should be connected to the Exhaust Muffler beneath the platform. If it is desirable to place a cock in the main-reservoir pipe so as to remove the brake valves without loss of air pressure, one may be put in the branch pipe connecting the main reservoir to the main-reservoir pipe; or two may be used, one in the main-reservoir pipe just below each brake valve, preferably inside the vestibule, but so placed that there will be no danger of its being closed by a broom when cleaning the car.

FIGURE 4.



SLIDE-VALVE FEED VALVE.

The Slide-Valve Feed Valve.

Figs. 4, 5 and 6 illustrate the device known as the Slide-Valve Feed Valve, used to maintain a predetermined train pipe pressure while the brake-valve handle is in Running Position.

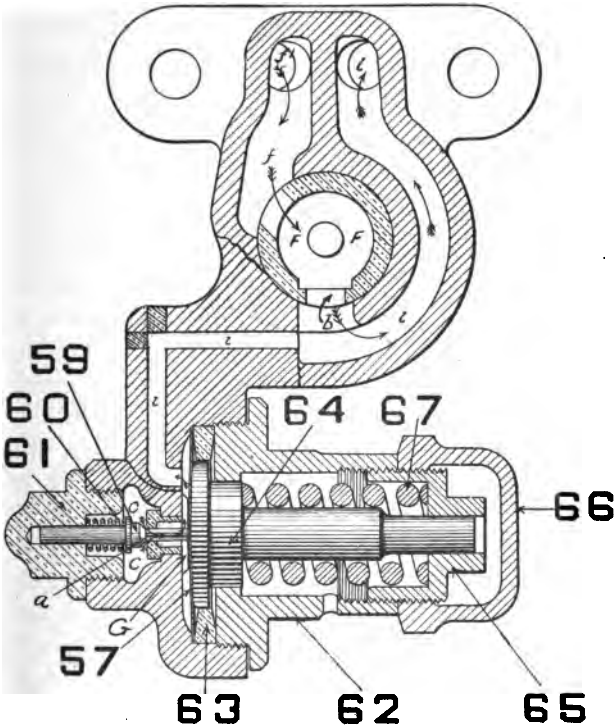
Fig. 4 shows a central section through the supply-valve case and governing device, and Fig. 5 a central section through the regulating valve and spring box and a transverse section through the supply-valve case.

Fig. 6 is a distorted view of the device to show diagrammatically the supply-valve case and spring box in one plane, to facilitate the description of its operation. The positions of ports have also been changed to more clearly indicate their connections.

Ports f^1 and i register with ports in the Brake Valve, designated by similar letters in Fig. 3, and, in Running Position, main-reservoir pressure constantly has free access, through passages f^1 and f, to chamber F. Chamber E, which is separated from chamber F by supply-valve piston 54, is connected with passage i, and thus with the train pipe, through passage c, c, port a (controlled by regulating valve 59) and chamber G, over diaphragm 57. Regulating valve 59 is normally held open by diaphragm 57 and regulating spring 67, the tension of which is adjusted by regulating nut 65. When so open, chamber E is in communication with the train pipe and is subject to train pipe pressure.

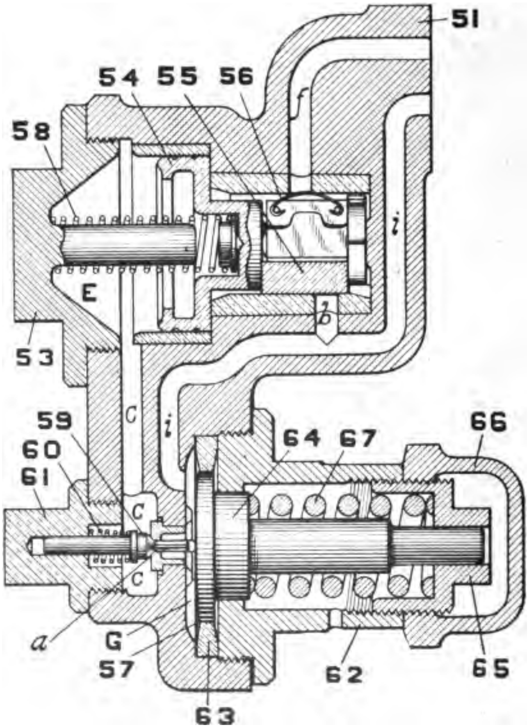
When the handle of the Motorman's Brake Valve is placed in Running Position, air pressure from the main-reservoir in chamber F forces supply-valve piston 54 forward, compressing its spring 58, carrying supply valve

FIGURE 5.



SLIDE-VALVE FEED VALVE.

FIGURE 6.



SLIDE-VALVE FEED VALVE
Distorted Diagrammatic View.

55 with it and uncovering port *b*, and thereby gains entrance directly into the train pipe through passage *i*, *i*. The resulting increase of pressure in the train pipe (and so in chamber G over diaphragm 57) continues until it becomes sufficient to overcome the tension of regulating spring 67, previously adjusted to yield at 70 pounds. Diaphragm 57 then yields and allows regulating valve 59 to be seated by spring 60, closing port *a* and cutting off all communication between chamber E and the train pipe. The pressure in chambers F and E then became equalized through leakage past supply-valve piston 54, and supply-valve-piston spring 58, previously compressed by the relatively high pressure in chamber F, now reacts and forces supply valve 55 to its normal position, closing port *b* and cutting off communication between the main reservoir and the train pipe. A subsequent reduction of train-pipe pressure reduces the pressure in chamber G and permits regulating spring 67 to force regulating valve 59 from its seat, thereby causing the accumulated pressure in chamber E to discharge into the train pipe. The equilibrium of pressure upon the opposite faces of supply-valve piston 54 being thus destroyed, the higher main-reservoir pressure in chamber F again forces it, with supply valve 55, forward and recharges the train pipe through port *b*, as before.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .014

The Quick-Action Triple Valve.

The Quick-Action Triple Valve is located in the brake system, as described in Instruction Pamphlet No. T. 5010.

This valve receives its name from the three distinct operations it performs in response to variations of train pipe and auxiliary-reservoir pressures: it (1) charges the auxiliary reservoir, and (2) applies and (3) releases the brakes. The various positions of the working parts of the triple valve, in accomplishing these results, are illustrated in Figs. 1, 2, 3 and 4, while Fig. 5 is a perspective view of the slide valve and its seat.

The various parts of the triple valve, as shown in the figures are 2, triple-valve body; 3, slide valve; 4, main piston; 5, piston packing ring; 6, slide-valve spring; 7, graduating valve; 8, emergency piston; 9, emergency-valve seat; 10, emergency valve; 11, emergency-valve rubber seat; 12, check-valve spring; 13, check-valve case; 14, check-valve-case gasket; 15, check valve; 16, strainer; 19, cylinder cap; 20, graduating-stem nut; 21, graduating stem; 22, graduating spring; 23, cylinder-cap gasket; 28, emergency-valve nut; and *i* and *k*, the feed grooves.

Strainer 16 is designed to exclude foreign matter from the triple valve. Piston 4 operates, in response to variations of train pipe and auxiliary-reservoir pressures, to open and close feed groove *i*, and controls the movements of the slide valve and the graduating valve. The latter is secured to the piston stem by a pin, shown in dotted lines.

The graduating valve, moved by the main piston, controls the flow of air from the auxiliary-reservoir through service ports *W* and *Z* of the slide valve.

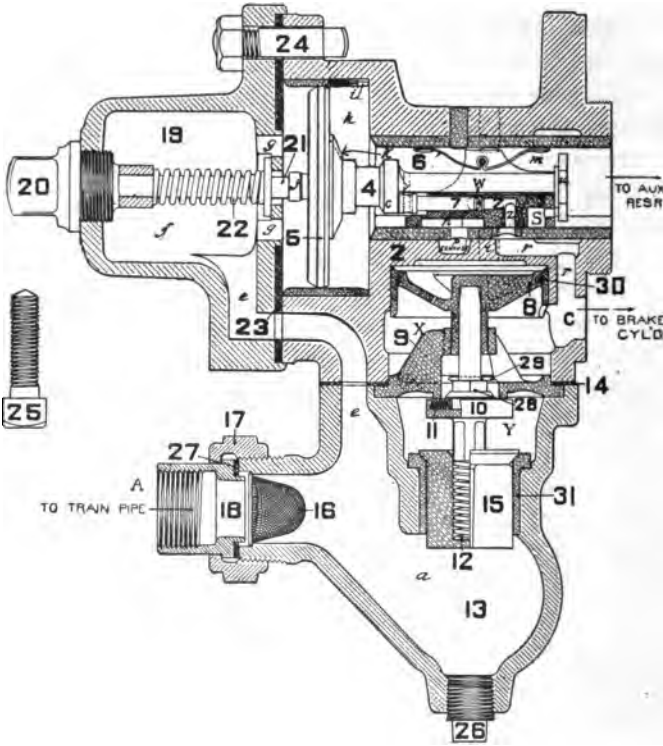


Fig. 2.—Service Application.

QUICK-ACTION TRIPLE VALVE.

The slide valve, moved by the main piston, controls communication between the brake cylinder and the atmosphere, between the auxiliary reservoir and the brake cylinder, and also between the auxiliary reservoir and the chamber above emergency piston 8.

CHARGING.

Air from the train pipe enters the triple valve at A (Fig. 1) and flows through passages *c, f, g* and *h,* past the main piston through feed grooves *i* in the bushing and *k* in the piston seat, and thence through chamber *m* to the auxiliary reservoir, as indicated. Air continues to flow from the train pipe to the auxiliary reservoir until the pressures equalize, when the main piston is balanced. The main piston constitutes a movable partition wall, separating train pipe and auxiliary-reservoir pressures, and, in studying the operation of the triple valve under various conditions, the first essential consideration is always as to which face of the main piston is exposed to the greater pressure: this determines the direction in which it will move. 70 pounds is the usual train pipe pressure, acting upon both faces of the main piston when the train pipe and auxiliary reservoirs are fully charged.

SERVICE APPLICATION.

To apply brakes for a service stop, a gradual reduction of train pipe pressure is necessary; and, for the purpose of illustration, the first reduction will be assumed to be one of five pounds, thus leaving a pressure of 65 pounds to act upon the train pipe face of the main piston, while the original 70 pounds still operates upon the auxiliary-reservoir face. As a result of this

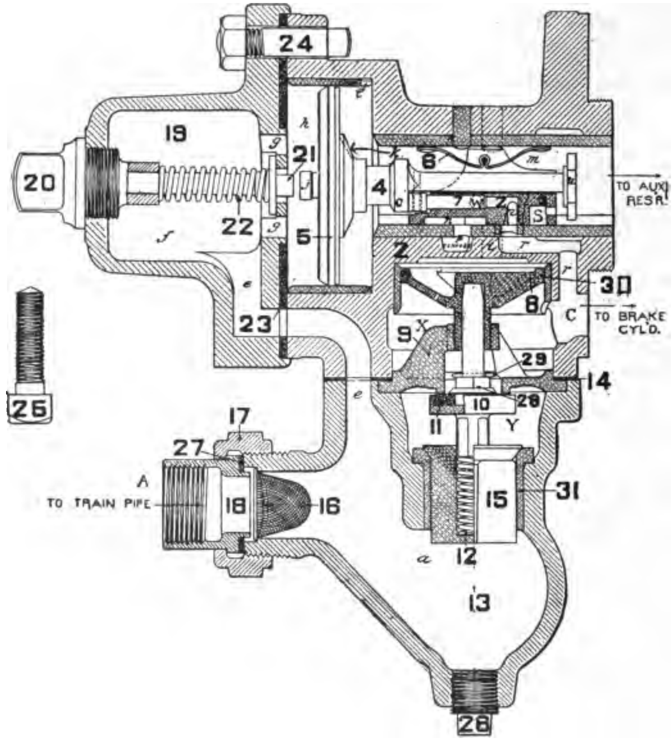


FIG. 3.—LAP POSITION.

QUICK-ACTION TRIPLE VALVE.

reduction, the greater auxiliary-reservoir pressure forces the main piston to the left (Fig. 2). As the piston moves, it closes feed groove *i*, cutting off communication between the train pipe and the auxiliary reservoir, and unseats graduating valve 7, establishing communication between transverse passage *W* and port *Z* of the slide valve. When the graduating valve has become unseated, the collar at the end of the piston stem engages the slide valve, which is then also drawn to the left in the further movement of the piston, thereby cutting off communication between exhaust cavity *n* in the slide valve and passage *r* leading to the brake cylinder. The movement of the main piston to the left is arrested by contact of its stem *j* with graduating stem 21, held in position by graduating spring 22. In this position, port *Z* in the slide valve registers with port *r*, and auxiliary reservoir air flows through port *W* and *Z* of the slide valve and passage *r* to the brake cylinder at C. When the auxiliary-reservoir pressure has become, through expansion into the brake cylinder, slightly less than that (65 pounds) upon the train pipe face of the main piston, the greater train pipe pressure forces the piston back sufficiently to seat the graduating valve, as shown in Fig. 3. This is known as the "lap" position.

If it be subsequently desired to apply the brake with greater force, a further train pipe reduction is made, which again leaves auxiliary-reservoir pressure in excess of that in the train pipe, whereby it again forces the main piston to the left and unseats graduating valve 7, the slide valve not moving. A corresponding further reduction of auxiliary-reservoir pressure results, through discharge of air into the brake

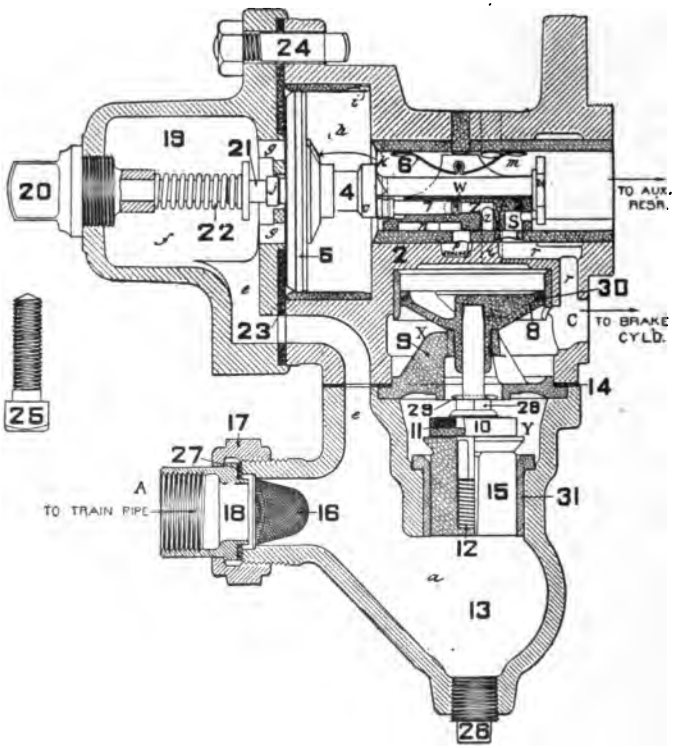


FIG. 4.—EMERGENCY APPLICATION.

QUICK-ACTION TRIPLE VALVE.

cylinder. Such train pipe reductions may be repeated until the auxiliary-reservoir and brake-cylinder pressures have finally equalized: the brake is then fully applied, and any further train pipe reduction is but a waste of train pipe air. A total reduction of about 20 pounds causes the auxiliary-reservoir and brake-cylinder pressures to equalize.

Release.

To release the brake, the motorman admits the excess pressure of the main reservoir into the train pipe, thus increasing the pressure upon the train-pipe face of the main piston until it becomes greater than that upon the auxiliary-reservoir face and thereby forcing the piston to its position at the extreme right, as shown in Fig. 1. In this position, the air in the brake cylinder is discharged through passage *r*, exhaust cavity *n* in the slide valve, and passage *p* into atmosphere, either directly or through the pressure-retaining valve, where employed. Feed groove *i* being again uncovered in this position of the piston, the auxiliary reservoir becomes recharged with air from the train pipe.

Emergency Application.

A gradual reduction of train pipe pressure causes the main piston to move to the left until stem *j* encounters stem 21, when the tension of the graduating spring prevents further movement; but a sudden train pipe reduction causes the main piston to move out so quickly that graduating spring 22 cannot withstand the impact of stem *j*, but yields so that the piston moves to the position shown in Fig. 4. In this position of the parts, a

diagonal slot in the slide valve (shown in Fig. 5) uncovers port *t* (indicated by the dotted lines just below the letter *Z*), which admits air from the slide-valve chamber to the chamber above emergency piston 8. Piston 8 is thereby forced downward and unseats emergency valve 10, allowing the pressure in the small chamber *Y* above check valve 15 to escape into the brake cylinder. Train-pipe pressure instantly raises the check valve and the brake cylinder at *C*. Air from the auxiliary reservoir simultaneously flows through port *S* of the slide valve and passage *r* into the brake cylinder; but, port *S* being very small in comparison with the passageway through chambers *a*, *Y* and *X*, very little auxiliary-reservoir air reaches the brake cylinder before the train pipe discharge thereto is completed. It thus occurs that, in an emergency application, an increased brake-cylinder pressure is secured through the presence of the air supplied by the train pipe in addition to that from the auxiliary reservoir, which is the only source of air pressure for the brake cylinder in service application of the brakes.

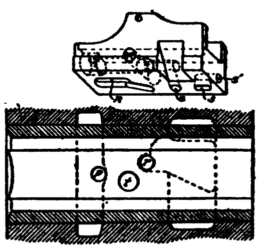


FIG. 5.

The rapid discharge of air from the train pipe into the brake cylinder, in the manner just described, causes a sudden reduction of train pipe pressure, which causes a similar operation of the triple valve upon the next car; the operation of that valve similarly affects the next, and so on, serially, throughout the train.

The release is accomplished in the same manner as that after a service application.

Installation.

The Quick Action Triple Valve should be bolted in position on the end of the auxiliary reservoir and the connection from the train pipe made to the union on the bottom part of the triple valve. In cases where wrought-iron auxiliary reservoirs are used with cylinders of the separated type having triple-valve heads, the triple valve should be bolted to the heads in the same manner as to the auxiliary reservoir of the combined type, and train-pipe connections made in exactly the same manner. A cut-out cock should be placed in this connecting pipe so as to cut off the supply to the brake system on that car without affecting the flow of air in the train pipe to other cars in the train.

Cleaning and Oiling the Triple Valve.

The following points, if borne in mind, will be of service in cleaning and oiling triple valves:

Tools that will facilitate the work are the following: A monkey wrench; a hammer and chisel; a Stillson wrench; a cotter-pin drift; a combination open-end S wrench that will fit triple-valve nuts and cap screws; a can of kerosene; a small sharp-pointed piece of hard wood; an oil or grease can; a squirt can; hose and union gaskets; a pair of plyers; waste; an old piece of chamois or of some cloth; and a suitable box in which to carry the tools.

The order of work found to be the most satisfactory is to first take the triple valve apart and immerse the removable internal metal parts in kerosene, leaving them there until the work upon the cylinder is completed; next remove the push rod and, if a freight cylinder, put a clamp upon the piston sleeve; remove the cylinder head

and piston; clean and oil the cylinder; and then replace the parts in the reverse order. The parts of the triple valve should then be thoroughly cleaned and replaced, after which the strainer should be cleaned, the brake tested, the piston travel adjusted, the retaining valve tested (and repaired if necessary), and, finally, the cylinder should be stenciled to show the date of cleaning and oiling. The pipe joints should be tested under pressure with soapsuds. The nuts upon the bolts which support the cylinder should always be examined, and tightened, if loose; if they are loose, the movement of the cylinder, when the brakes are applied, produces leaks in the pipe joints.

In cleaning the triple valve, special care should be given to the slide valve, the graduating valve, the slide-valve seat, the packing ring of the triple-valve piston, and the emergency rubber-seated valve. In order to avoid springing the triple-valve-piston packing ring, it should never be removed except for the purpose of renewal. Cloth should be used on the triple-valve parts, and a final application of the chamois will remove the possibility of trouble from lint. The triple-valve-piston packing ring should be caused to work freely in its groove before replacing.

Seven or eight drops of oil are sufficient for lubricating the entire triple valve, as none should be used on the quick-action parts. The slide valve, its seat, the triple-valve-piston packing ring, and the bushing in which it works should receive special consideration in respect to sufficient lubrication, and care should be taken not to permit any oil to get upon the gaskets or rubber-seated valve.

The graduating and check-valve springs should be examined and renewed if they have a material permanent set.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

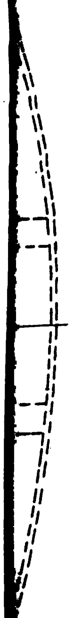
P. F. No. 015

January, 1904

Instruction Pamphlet No. T 5013

Straight-Air Brake Equipment with Axle-Driven Compressor

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.



The Westinghouse Straight-Air Traction Brake with Axle-Driven Compressor.

This equipment is comprised of the following parts:

First—An Air Compressor actuated from the car motors by being geared directly to an axle of the car instead of to an independent electrically-driven motor.

Second—A Compressor Regulator which automatically controls the operation of the compressor, thereby maintaining the pressure and regulating the supply of compressed air.

Third—A Reservoir in which the compressed air is stored.

Fourth—A Brake Cylinder, the piston rod of which is connected to the brake levers in such a manner that when the piston is forced outward by the air pressure the brakes are applied.

Fifth—An Operating Valve, mounted at each controlling point of the car, by means of which the compressed air is admitted to or released from the brake cylinder.

Sixth—A System of Piping, which, with various small fittings, forms the connections between the above mentioned parts, and when trailers are used includes flexible hose and couplings between cars.

Seventh—A Safety Valve, placed in the air supply system, to prevent any possibility of accumulating an excessive pressure.

Eighth—Also often specified is a Chime Whistle Set, operated by air pressure, as a warning of approach in place of a gong or bell.

Fig. 1 shows the general arrangement of apparatus and piping as applied to a double-truck car, while Fig. 2

is a diagrammatical illustration showing the relative location of the various essential parts of an equipment upon a motor car and trailer.

The application of the brakes by admission of compressed air from the reservoir to the brake cylinder is effected by opening either the small or the large port in the operating valve, thereby causing the piston in the cylinder to move outwardly, applying the brakes with a greater or less degree of force, depending upon which port is used and the length of time it remains open. In an ordinary service stop the small port is opened, which allows air to flow gradually from the reservoir to the brake cylinder; but in an emergency stop the large port is employed, allowing a larger amount of air to flow almost instantly into the brake cylinder, thus the motorman is able to apply the brakes with such pressure up to the maximum and in as small a space of time as is desired. After admitting air to the cylinder, if the handle is placed in the position where all ports are closed, the air already admitted to the brake cylinder is retained there, thus holding the brakes applied; a further movement of the handle to the release position connects the brake cylinder with the atmosphere, permitting air to escape and thereby releasing the brakes. A gradual release of the brake may be obtained by permitting a portion of the air in the cylinder to escape and then returning the handle to the position where all ports are closed.

On cars running in city and also interurban service we have introduced a system (see Fig. 2) comprising two reservoirs, a preliminary of moderate capacity (usually 12″ diameter and 20″ long) connected directly to the discharge pipe of the compressor and the operating valves, and a larger main reservoir that is con-

nected to the preliminary through a duplex check valve, shown and described in Instruction Pamphlet No. T 5009. The tension on the spring 14 is so adjusted that the air pressure on the diaphragm 11 must have attained 35 lbs. before the valve 8 is lifted from its seat, and air may pass into the main storage reservoir. Thus, air may flow freely through the check valve 6 from the main storage reservoir to the preliminary, but about 35 lbs. pressure must be attained in the latter before any air can pass into the main reservoir, so that a car starting out of the barns with empty reservoirs will not have run 100 yards before a sufficient pressure is attained in the preliminary reservoir to enable the motorman to operate the air-brake. It also insures sufficient braking pressure on interurban cars when running at slow speed through the cities, and effectually removes all objection against the axle driven compressor on this score.

Installation of Axle-Driven Compressor Equipments.

In Fig. 2 we show the arrangement of the various apparatus comprising our axle-driven compressor equipment. This is the result of careful study and much experience, and we earnestly recommend that the parts of this equipment be connected in the same relative order as shown in this diagram; otherwise trouble may occur, due to the presence of water and dirt in parts which will not be the case if properly connected.

In figuring out the best possible locations for the compressor, brake cylinder and reservoir due regard must be had to the electrical apparatus already under the car or to be placed there, as well as to the fact that those parts requiring inspection and care should be placed as far as

possible in the most accessible locations to facilitate inspection and maintenance. After these locations have been settled upon we would recommend that the apparatus be installed according to the instructions given in the instruction pamphlets mentioned on the last page of this pamphlet.

Instructions for Operating the Straight-Air Brake.

As the Operating Valve has notches which mark the position of the handle for the various positions of the valve, it is very easy for one to operate the brake with certainty the first time, but smooth, quick and accurate stops are only made after a little practice. The operating valve handle must always be inserted at the lap position where the slot in the body is enlarged for that purpose, and withdrawn at the same point when changing from one end of the car to the other. When the handle is in lap position, as indicated by the deep notch, the valve is so placed that air can neither pass into nor out of the brake cylinder. Moving the handle of the O. V. J. valve to the end of the slot toward the left places the valve in full release, while a movement to the right, as far as the small notch, opens the small port, and a further movement to the right end of the slot opens wide the large port. A good deal of compressed air will flow through a small opening in a short time, so that in order to make a light application of the brakes, move the handle to the small notch, and then quickly back to the deep notch or lap, thus the air that has been admitted to the cylinder is retained there, holding the brakes applied. To partially release the brake reduce the pressure in the cylinder by turning

the handle to the release position at the left end of the slot, and almost immediately returning it to lap, thus allowing a portion of the air to escape from the cylinder.

The quickest stop obtainable is made by applying, throughout the stop, the greatest pressure possible to the wheels without causing them to slide on the rails, and the higher the speed the greater the pressure that may be applied without danger of sliding. Thus it is evident that in order to make a quick stop apply full pressure at once, and release it gradually as the speed falls; this method will also give a smooth stop, as the rapid reduction of speed at the end of the stop, which throws passengers, is avoided. Therefore, in making a service stop, admit twenty-five or thirty pounds of air pressure to the brake cylinder quickly at the beginning of the stop by partially opening the large port, and release it little by little as the speed drops, retaining about ten pounds in the cylinder till the car stops. A little experience will show the distance required in which to make a stop from a given speed so that all stops will be made quickly, smoothly and with but one application of the brake. A succession of applications and releases while making a stop imparts a very disagreeable motion to the car, is most wasteful of compressed air, and reprehensible in every respect. For the emergency stop admit full pressure (about sixty pounds) immediately, without even waiting till the controller is turned off, then apply sand and release a little of the pressure as the speed drops.

Upon receiving the signal to go ahead, turn the handle to the release position before turning on the electric power. When descending a grade a beginner generally makes the mistake of putting the brake on too hard at the start; it cannot be expected that the instant the brake

is applied the car will take the speed desired; make an easy application at first, hold the handle at "Lap" and give the car time to feel the effect of the brake, then if the speed is still too high, let in a *little* more air; repeat the operation as often as necessary until off the grade, in case it is a long one.

When leaving a car, always set up the hand brake, as some one might tamper with the cut-out cocks. Before starting from the car barn, be sure all cocks are properly set and that there is a good supply of air in the reservoir. Insert the handle in its socket in the operating valve and throw it around to emergency, then back to release, to see that it works freely. Try the air brake both in "service" and "emergency" to make sure that it has not been left improperly connected, etc. After this trial and as long as proper pressure is maintained the brake may be relied upon to perform its duty.

TRAILERS—Care must be taken in making up trains, that all hose couplings are thoroughly united so that the air will apply throughout the entire train. All the cut-out cocks must be opened, except those on the rear of the last car and on the front of the motor car, which must be closed. In uncoupling the cars close the cocks and disconnect the hose before pulling the drawbar pin.

The air brake is essentially a labor saving device for the motorman, and it is scarcely necessary to ask for his coöperation in the use and care of it. Its success and general adoption for fast and heavy street railway service depends very much on his interesting himself in its use, and having an intelligent understanding of the functions of the various parts, that he may readily notice when anything about them is not working properly, and report the trouble before it becomes serious. Like the other appara-

tus of a street car, the air brake will not operate indefinitely without attention, and the old proverb of "a stitch in time saves nine" applies in this case as in all others.

The following Instruction Pamphlets, added to this one, go to make up a complete set as applied to the Straight-Air Brake Equipment with Axle-Driven Compressor:

	Instruction Pamphlet
Axle-Driven Compressors	No. T 5014
Compressor Regulator, D. R. E.	T 5015
Reservoirs	T 5005
Brake Cylinder	T 5006
Operating Valves	T 5007
Piping	T 5008
Chime Whistle Set	T 5009

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 016

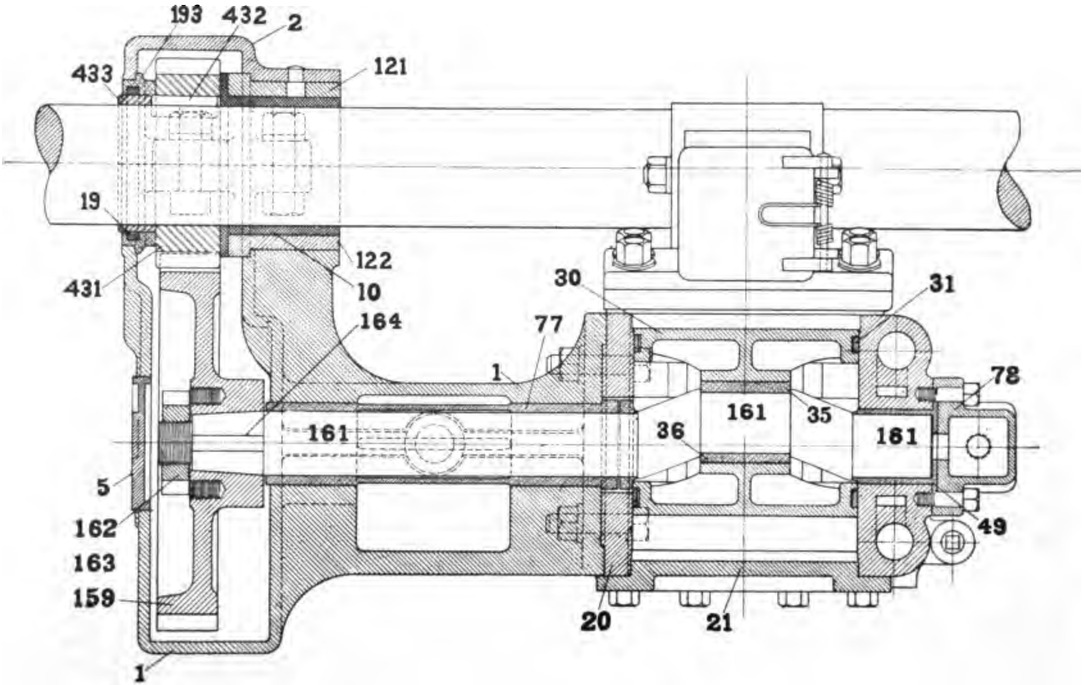
January, 1904

Instruction Pamphlet No. T 5014

Axle-Driven Air Compressors

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U.S.A.

FIGURE I.

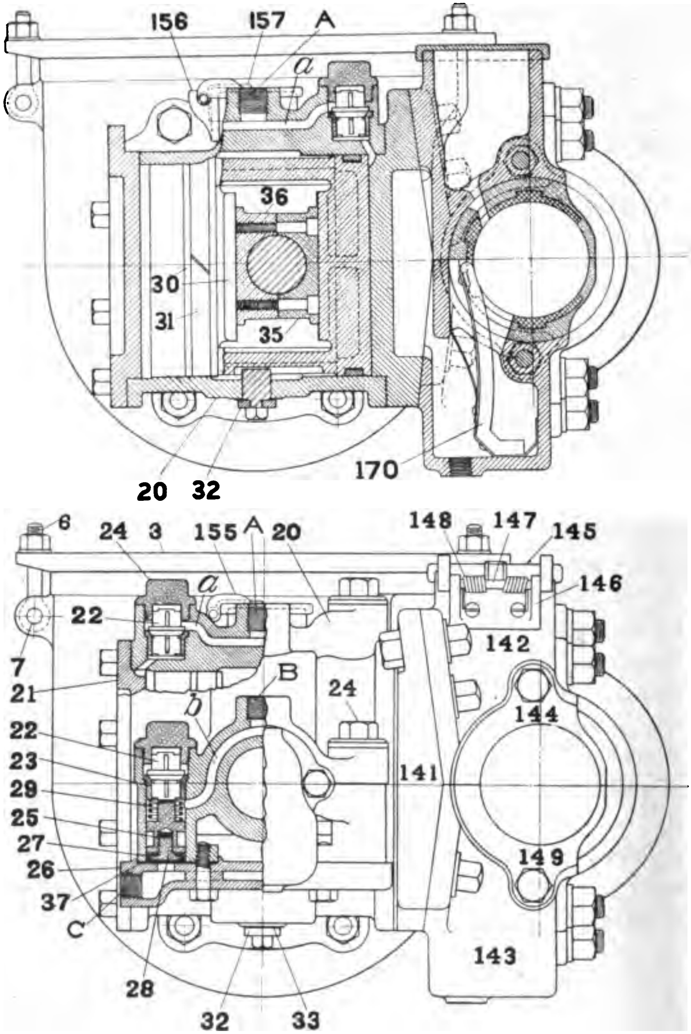


AXLE-DRIVEN COMPRESSOR.

Axle-Driven Air Compressor.

Figs. 1 and 2 show the construction of the A. C. N. form of this type of compressor. From the sectional plan, Fig. 1, it will be noted that the cylinder 20 has its axis horizontal and at right angles to the car axle. The two discharge valves are located in suitable chambers on the top at each end of the cylinder (see sectional elevation on Fig. 2) and a discharge passage *a* leads from these chambers to the discharge orifice A, midway between them. Lower down, by the side of the cylinder are the two suction valves 22 beneath which are cylindrical chambers connected to each other and to the suction orifice B by a passage *b* above the crank-shaft end-bearing. All four valves are interchangeable, as are also the removeable seats 23. It will be noted that the valves are seated by gravity and have no springs to wear, break or gum up. The cylindrical chambers beneath the suction valves are provided with pistons 25, fitted with cup leathers 27 and normally held at the bottom of their chambers by the springs 29. The casting 26 forms a cover for these chambers and connects them below the trip pistons 25. Thus when compressed air is admitted at C, the trip pistons are forced upward, thereby lifting the suction valves and cutting the pump out of action. This method of regulating the action of the pump is much superior to the old way of permitting the pump to discharge into the atmosphere, because when cut out, the four valves do not move, the discharge valves remaining on their seats, assisting the check valve in preventing a backward flow of air from the reservoir, and the suction valves being held at the upper end of their stroke by the trip pistons. The air is simply drawn back and forth in and out of the suction orifice, no other work being done.

FIGURE 2.

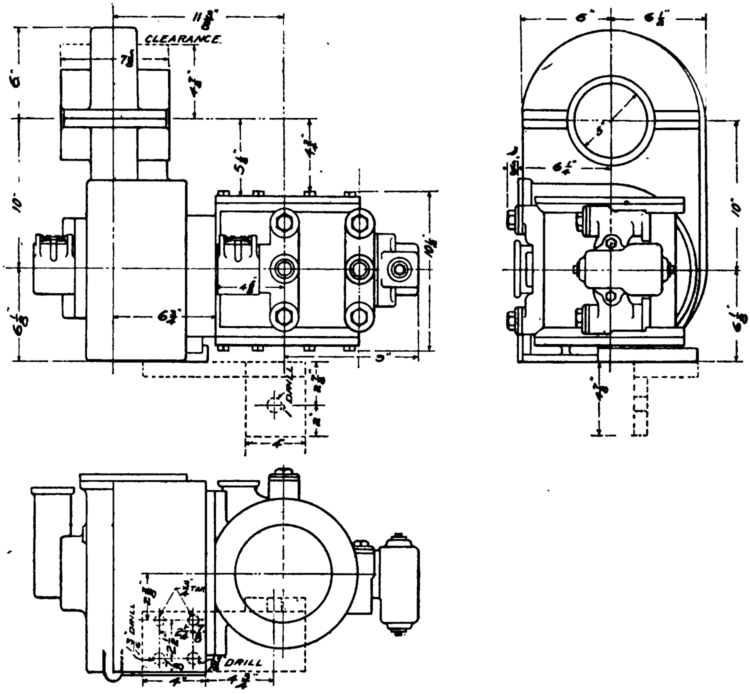


AXLE-DRIVEN COMPRESSOR.

The piston 30 is made of a single casting in the form of two discs connected at top and bottom, and left open at the sides in such a manner as to form a yoke, through the center of which the crank shaft passes. The inside rectangular surface of the discs, parallel to the ends of the piston, are machined, and the crank-pin brasses, 35 and 36 (which also serve as a crosshead), fit in between these two surfaces in such a manner that they are free to move vertically but not horizontally without also moving the piston. Thus the rotary motion of the crank-pin is transformed into the reciprocating motion of the piston. Each disc is provided with a packing-ring 31.

The center line of the crank shaft 161, is parallel to the car axle, and passes through the cylinder at its middle point. The piston is prevented from turning in the cylinder by a guide 32 which projects into a suitable groove in the under side of the piston. The side of the cylinder opposite to that of the suction valves is provided with a flange by which it is bolted to the oil-tight housing 1 that encloses the gear on the pump shaft as well as the driving gear secured to the car axle. These gears are made larger than necessary for the work that they have to perform, so that they will last a long time. When practicable, we recommend the use of a solid gear on the car axle, although we have supplied many hundreds of split axle gears that have been in successful operation for a number of years. This housing is provided with bearings 10 on the axle which support this end of the compressor and serve to keep the two gears in mesh. The position of the compressor on the car axle must depend on the kind and size of electric motor used in propelling the car. It is manifest that the compressor bearings and axle gear must be placed on the axle at a point that will not interfere

FIGURE 3.



OUTLINE OF G. C. B. COMPRESSOR.

with the motor bearings and field casting. For this reason, also, the length of the housing 1 is varied so as to bring the pump cylinder close up to the gears, or farther away, according to the space available. When there is sufficient space on the axle to admit of the compressor bearing being placed on the wheel side of the motor, and the design of the motor bearing will permit, the cylinder is placed close up to the gears, housing 1 being very short as shown in Fig. 3, opposite page. Should the construction of the motor render such a design of compressor impossible, the crank-shaft and housing are prolonged, so that the cylinder may come into the space between the motor bearings. When this is done an auxiliary bearing, 142 and 143 (Fig. 2), is fixed to the cylinder head 141. As the field casting of the motor generally comes very close to the axle at this point, the auxiliary bearing shells 144 and 149 are made quite thin on the back and are bolted to the bearing housing to hold them securely in place. To insure proper lubrication of this bearing, the grease cup with hinged lid 145, is provided, and also an oil well with a felt wick 170, which continually feeds oil to the journal. On top of the cylinder is an opening, with a lid 155, by which heavy oil may be poured into the chamber in the piston where the crank pin works, so that all parts run in a bath of oil. The front of the compressor, opposite to the axle bearings, is supported by suitable brackets which are mounted upon it, and the truck frame respectively, with a rubber cushion between them to deaden the vibrations, as shown on Fig. 5.

Standard Forms of Axle-Driven Compressors.

Owing to the widely varying conditions met with in street railway practice, due to the different types of trucks and motors, diameters of wheels and speeds, it has been necessary to establish several forms of our geared compressor. We have found, however, that one design of pump cylinder answers all purposes, the difference in the various forms of compressors being confined to the gear ratios necessary to keep the piston speed within safe limits, and the design of housing required to meet the conditions above stated. The different forms of axle-driven compressors and their gear ratio are designated as follows:

Form	G. C. B.	10″ x 10″	gears.	
"	G. C. C.	6″ x 10″	"	
"	G. C. D.	6″ x 10″	"	
"	G. C. G.	8″ x 12″	"	Not kept in stock.
"	G. C. J.	10″ x 10″	"	Extended, with auxiliary bearing.
"	A. C. N.	6½″ x 12″	"	Extended, with auxiliary bearing.

FORM G. C. B.—10″ axle gear, 10″ pump gear (see Fig. 3), may be mounted on the same axle with the motor. The space required on the axle between the motor bearing and the hub of the wheel is 7½″. The distance from the center line of the axle to the extreme end of the motor bearing on the commutator side, not to exceed 5⅛″—otherwise form G. C. J. will have to be used for this combination of conditions. The limit of speed for which this compressor is designed is 22 miles per hour when mounted on an axle with 33-inch wheels. For speed limits when other diameters of wheels are employed see chart in Fig. 9, page 17.

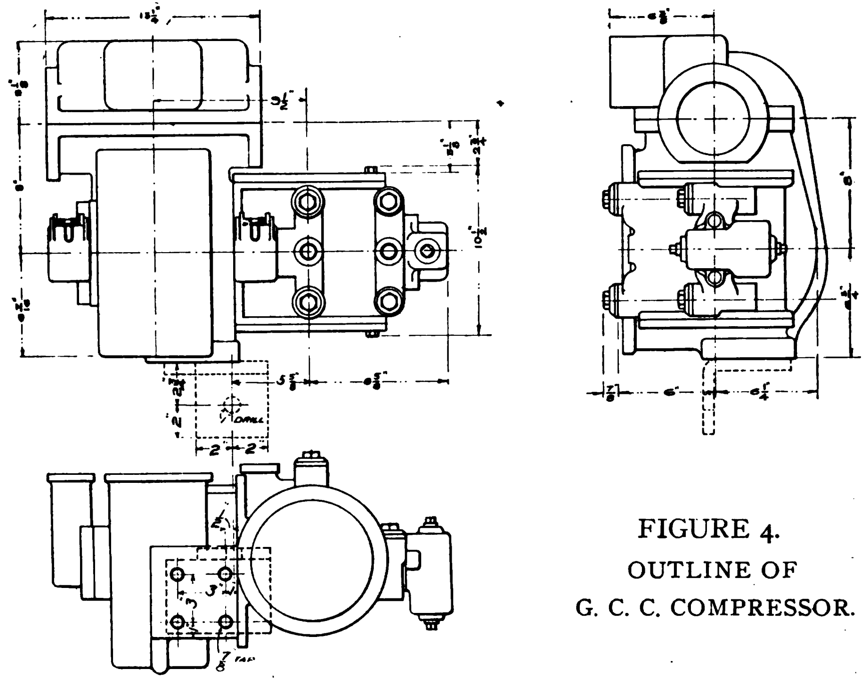


FIGURE 4.
OUTLINE OF
G. C. C. COMPRESSOR.

Form G. C. C.—6″ axle gear, 10″ pump gear. See Fig. 4. The bearing of this compressor takes up 15 inches of axle space and cannot be mounted on the same axle with a motor. It is designed for mounting on a $3\frac{3}{8}$-inch axle with 20-inch wheels, under which conditions the maximum allowable speed of the car is 22 miles per hour. When supplied with a special steel gear and bronze bearing shells this compressor can be mounted on a free axle 4 inches in diameter (maximum); and when 33-inch wheels are used, the maximum speed will be 37 miles per hour. (See chart, Fig. 9.)

Form G. C. D.—6″ axle gear, 10″ pump gear. See Fig. 5. A modification of the G. C. C. for use on pony axles with 18-inch wheels, in which the center line of the cylinder is two inches above the center line of the axle. With the exception of a heavy rib, one inch deep, for protection in case of derailment, no part hangs lower than five inches below the center line of the car axle. Other particulars are the same as with the G. C. C.

Form G. C. G.—8″ axle gear, 12″ pump gear. Similar in form to the G. C. B. and may be mounted on the same axle with the motor, but requires a space of $8\frac{1}{2}$″ between the motor bearing and the hub of the wheel; the distance from the center line of the axle to the extreme end of the motor bearing on the commutator side cannot exceed $5\frac{1}{8}$″—otherwise Form A. C. N. will have to be used. The maximum axle diameter is $4\frac{1}{2}$″. The speed limit with 33″ wheels is 33 miles per hour. Note that this form of compressor is not carried in stock, and will be supplied only when special conditions warrant so doing.

Form G. C. J.—10″ axle gear, 10″ pump gear. See

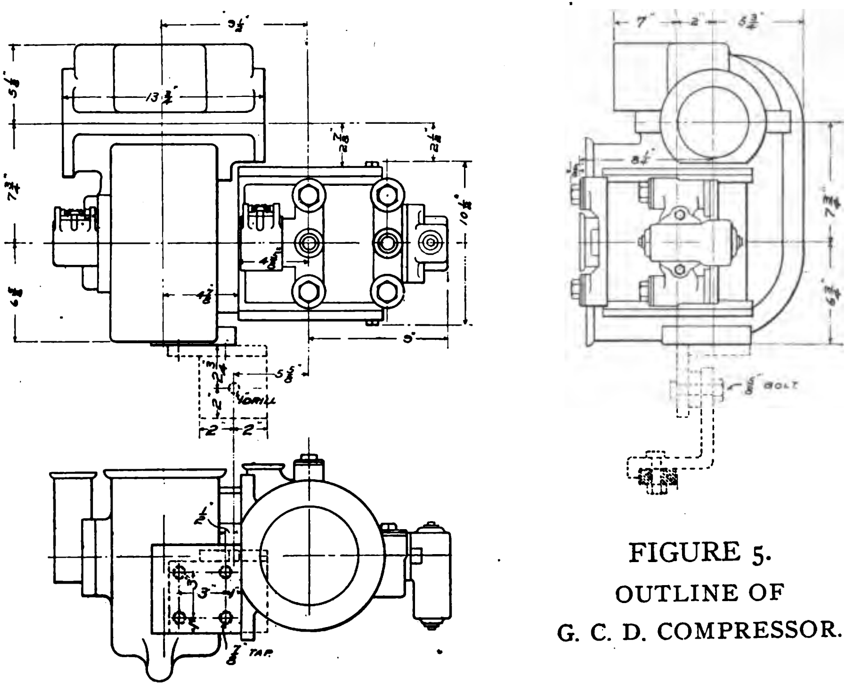


FIGURE 5.

OUTLINE OF

G. C. D. COMPRESSOR.

Fig. 6. This compressor is designed for the same service as the Form G. C. B., but is substituted for it when the motor bearing above mentioned projects so far as to prevent placing the pump cylinder close to the pump gear case, in which event the housing and crank shaft are prolonged 5½″. This brings the cylinder into the space between the two motor bearings, and to support this end of the compressor, an auxiliary bearing is secured to the cylinder head, as described on page 103. The axle space between the motor bearing and the hub of the wheel should be 6″, but may be safely reduced to 5¼″. By using a special motor bearing shell that serves for both compressor and motor the space between the hub of the wheel and the face of the motor bearing may be reduced to 4¼″, with certain styles of motors. When less than 5¼″ space is available, the question should be referred to our Engineering Department, together with full data as to the style of motor and wheels to be used. The maximum axle diameter is 4½″. Speed limits are the same as for the Form G. C. B.

FORM A. C. N.—6½″ axle gear, 12″ pump gear. See Fig. 7. It is constructed to meet the requirements of fast interurban service, and is provided with the auxiliary bearing above described. The standard length of axle space is 7⅜″, which may be reduced to 6¼″, if necessary. The maximum diameter of axle is 4½ inches. The maximum speed with 33-inch wheels is 41 miles per hour. See chart, Fig. 9.

INSTALLATION OF THE AXLE-DRIVEN COMPRESSOR.

If the Compressor is to be mounted beside a motor, care must be exercised in locating the hole for the dowel pin of the gear, so that the compressor bearing shell prac-

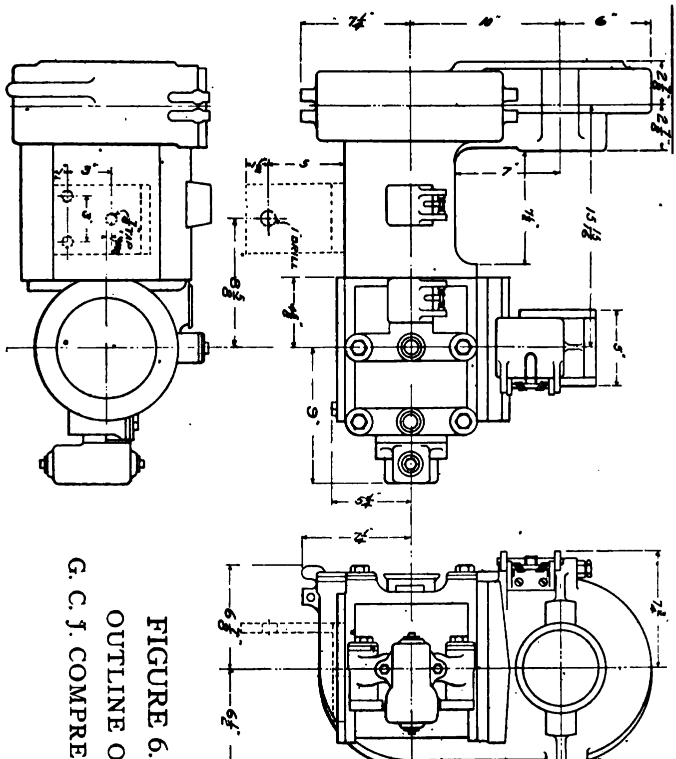


FIGURE 6.
OUTLINE OF
G. C. J. COMPRESSOR.

tically fills the space between the gear and the bearing of the motor. As these two bearings do not revolve the wear between them will be very slight, and the side play of the motor will increase very slowly. The hole in the axle should be made with a twist drill guided by a jig, made for the purpose, which insures an accurate fit of the dowel in both axle and gear. The pin should be driven firmly into the axle and the gear driven onto the pin; when the two halves of the gear have been drawn together, batter the ends of the studs to preclude any possibility of the nuts working loose. It is seldom necessary to remove an axle gear, and in such an event the nuts can be readily split with a sharp chisel. As stated on page 101, we recommend, when practicable, the use of solid gears to be pressed on the axle. A number of roads have adopted this method and consider it of great advantage, a certain percentage of their spare axles being equipped with gears, thus obviating the necessity of changing gears from one axle to another when wheels are changed. When the gear is secured in its proper place on the axle, smear the journals with oil, put on the bearing shells 10 (Fig. 1) and then the housing cap 2, seeing that the dowel pins in same enter properly in the holes prepared for them in the bearing shells. The shells are split at 45° from the parting of the housing, so that the cap holds the shells while the compressor is being put in place. See that all nuts are set up solid and locked in place by the spring washers provided for this purpose. Before tightening the bolts of the housing cap of the G. C. J. and A. C. N. forms of compressor, the auxiliary bearing should be put in its place on the cylinder head. Be sure there is 1/16″ play between the shells of the latter bearing and the motor field casting. The G. C. B. form of Compressor, having

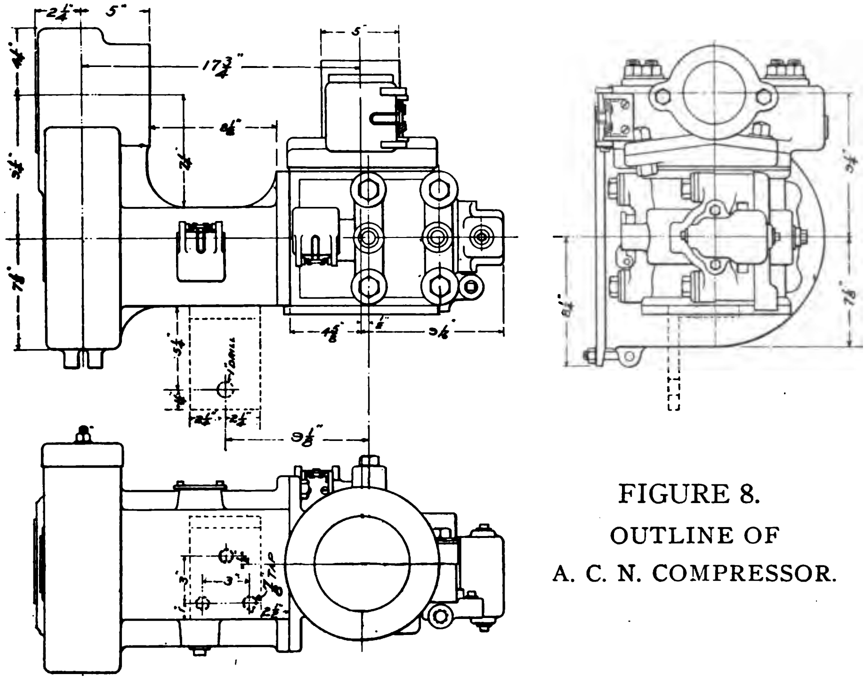
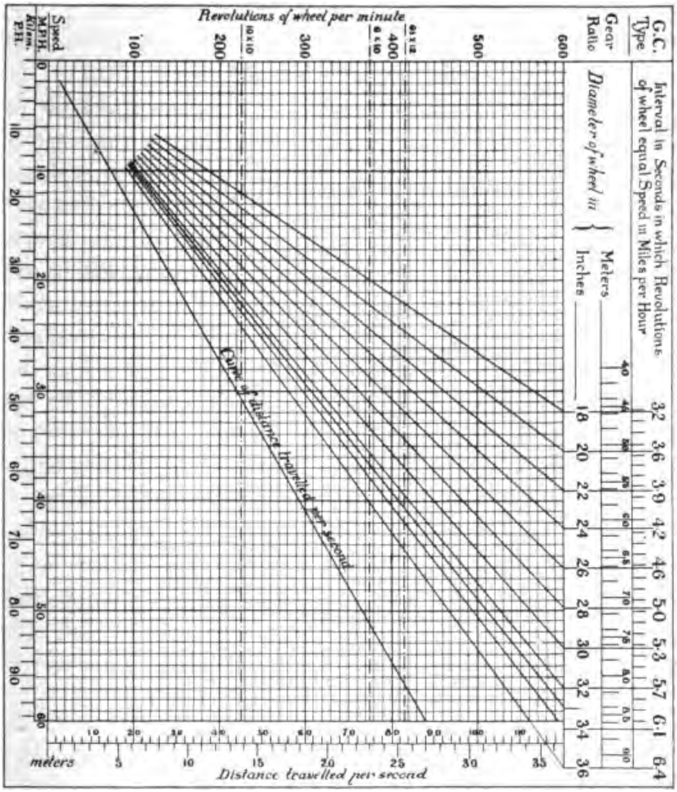


FIGURE 8.
OUTLINE OF
A. C. N. COMPRESSOR.

but one bearing on the axle, must have its suspension at some point on the line passing through the middle point of the axle bearing and the center of gravity of the machine. On the housing, is a lug provided with two ¾" tap and two ¾" through bolt holes, to which the wrought iron suspension bracket should be attached. This must be made to suit the construction of the car, but in many cases (see Fig. 3) can be a bar of ¾" x 4" iron 10¾" long, placed vertically, covering the lug on the housing and having welded to its upper edge at one end a piece 4" wide and 4⅞" long, protruding horizontally toward the front. A 1" hole in the center of this protruding piece will lie on the line mentioned and therefore be a proper location for the suspension bolt. The latter may hang from the floor of the car, but it is better to support the compressor from a part of the truck when possible, as there is less oscillation in these parts. We supply a rubber cushion to be placed between the supporting piece and the bracket to deaden the vibration; a ⅝" bolt, with suitable washers, will prevent the rubber cushion from working out of its place and the compressor from lifting on reversal of movement of car. This bolt *must not* be screwed up solid, as the lost motion in journal boxes, etc., of the truck necessitate a corresponding freedom of motion at this point to prevent any uncalled for strain on the compressor.

The discharge from the compressor through the ¾" tapped opening in the top of the cylinder must be flexibly connected with the reservoir by means of a hose. With each equipment we send a length of extra heavy hose (4 ply) provided with a special angle union fitting at one end to be screwed into the compressor, and a ¾" nipple at the other, which should be screwed into the

FIGURE 9.



SPEED CHART.

¾" check valve located at the end of the pipe leading direct to the reservoir. *All* other connections to the reservoir must be made at the end opposite to that from which the air enters from the compressor, so that all air will pass through the reservoir and deposit there any moisture or oil which may be brought over.

To insure long life to the valves, pistons, etc., it is necessary to take every precaution to prevent dust being drawn into the pump. The *Suction Fitting,* therefore, should invariably be mounted in a cheese cloth covered box as described on page 48, and the connection made direct to the suction orifice of the pump by means of the proper length of ¾" 3-ply hose. If the cross timber is not located sufficiently near the pump to obviate the necessity of it, a short length of ¾" pipe may be placed between the hose union and the nipple. In all cases before screwing up the hose union, grease the thread of same that it may not become rusted in place, thus making it very difficult to disconnect the flexible coupling.

In this way the suction is supplied with ample screen surface which, on account of its extreme flexibility, will, when the pump is cut out and the screen is subjected alternately to suction and discharge, tend to shake off any dust that may have lodged on it while the compressor was in action.

Inspection and Care of Axle-Driven Compressors.

The lubricant in the housing should not be allowed to get below the pump shaft; the frequency with which it is necessary to replenish this supply depends so much upon the service that the car is in, and the condition of the bearings on the axle, that it is not

possible to say just how often this will be. At first the cover should be removed from the gear housing once a week and enough grease be added to bring the level well above the pump shaft. By noting the amount remaining in the housing each time, the intervals at which it will need to be replenished can readily be determined. For this lubrication a grease about the consistency of vaseline should be used; a very heavy West Virginia crude oil is the best for the cylinder, and it should be kept at the level of the crank-shaft. Pour it in through the opening on the top of the cylinder or extension of the housing. As stated above, *we decline to assume any responsibility for breakages that may occur in compressors which have not been properly lubricated.*

Other than attending to the proper supply of lubricant there is little to do besides seeing that no nuts have loosened; this latter inspection should be made once a day, if possible, and need take but a minute, as all nuts or bolts that can loosen are on the outside.

At regular intervals (every three months if the car is in hard service) the Compressor should be taken off the axle and cleaned and examined thoroughly. The bearings on the axle should then be replaced and the old ones rebabbitted for the next one to be overhauled. As this is practically the only place where oil can escape from the compressor it is necessary to keep these bearings close to the axle.

If pressure cannot be raised in the reservoir, disconnect the discharge-hose union and, while the car is running, hold the hand over the opening; if for each revolution of the axle there are two equally sharp spurts of air the pump is all right. A large leak is somewhat difficult to locate, as with an axle compressor the car must be in mo-

tion to do any pumping; for this reason roads having a large number of air brake equipments should have a stationary compressor, either belt or motor driven, which with two reservoirs makes a very convenient testing outfit. In case such an outfit is not to be had, run the car and if the air escapes from the exhaust pipe it is evident that the operating valve does not seat well: dirt may have gotten between the valve and seat. If this is all right see if a pipe has cracked or a fitting broken. In the event of the compressor failing to pump, remove the fitting under the suction valves and see if the little trip pistons are free; if the suction or regulator pipes were not properly cleaned, dirt may cause one of these pistons to stick and hold the suction valve open. It is also possible to feel from below whether the valves are seating properly or not. If one suction valve sticks, the pump will attain maximum pressure, but it will take twice as long to do it. If one discharge valve sticks open, the pump will attain about 20 pounds and cannot get much higher.

Although the pump valves are all machined alike, each valve is ground to its own seat; therefore when cleaning them, be sure to put them back on their old seats, otherwise they are liable to leak as no ground valves are interchangeable without regrinding on the new seats. Should the pump fail to cut out, take down the trip fitting and see that the trip pistons are free; instances have occurred of a long trip piston packing leather being caught between the trip fitting and cylinder body when bolting the fitting on.

A kink in the suction hose by which it is doubled

over on itself will cause the compressor to pump slowly owing to the diminished supply passage.

IMPORTANT.

When the cover of the housing is removed to oil the compressor, *be very particular* that nothing is allowed to drop in. The lodging of a "stray" bolt or nut between the gears will destroy the whole machine.

INSTRUCTIONS FOR ORDERING SPARE PARTS OF AXLE-DRIVEN COMPRESSORS.

Note the letter that designates the form of the G. C. Type of compressor that is used, and when ordering spare parts, state the symbol of the compressor, together with the piece number and name of the part, and the *serial number* of the compressor which is stamped on the shield of the housing between the cover and the cylinder. For example, six sets of axle bearings are wanted for a $6\frac{1}{2}''$ x $12''$ geared compressor, whose serial number is 356; the symbol of this form is A. C. N., and marked on the casting are found the figures 10. The order should read: Six sets of A. C. N.-10 (axle bearing $3\frac{7}{8}''$ diameter) compressor No. 356.

A part that performs the same functions in the different forms of the G. C. type of compressors will always bear the same number, in whatever form it may be found. The last of the three letters forming the symbol of the whole compressor determines the particular form to which the piece under consideration belongs, therefore always give the three letters together with the number and name of part.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P F. No. 017

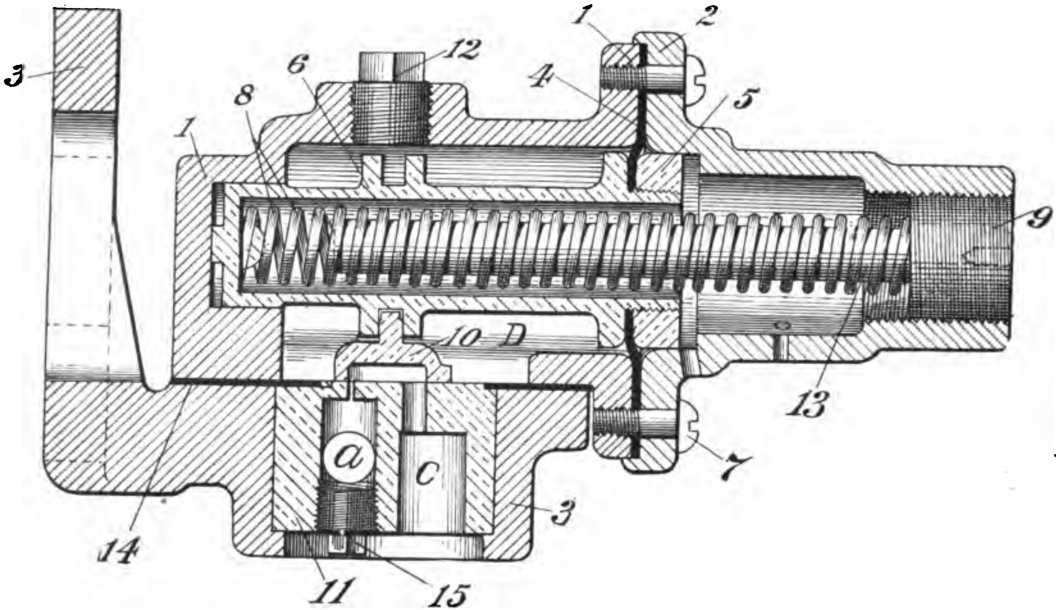
January, 1904

Instruction Pamphlet No. T 5015

Axle-Driven-Compressor Regulator, D. R. E.

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortland Street,
New York, U. S. A.

FIGURE 1.



COMPRESSOR REGULATOR, FORM D. R. E.

Compressor Regulator D. R. E.

The Regulator, shown in section in Fig. 1, is almost identical in operation to the Form E Electric Governor described in Instruction Pamphlet No. T. 5003, except that the air pressure is admitted to the cylindrical chambers under the suction valves in the axle-driven compressor, instead of under a piston in the governor to actuate a cut-out switch. Therefore, the design is different only in so far as is necessary to meet the different requirements. The Regulator consists of a chamber D (in free communication with the main reservoir) one wall of which is formed by the diaphragm 4 subjected on one side to the reservoir pressure and on the other to the pressure of the atmosphere and a graduated spring 8. Secured to the diaphragm by means of the nut 5 is the guide 6 in which the spring 8 is seated. This guide, supported at the other end in a suitable cavity in the body 1, has a double flange around it into which fits the guiding lug of the slide valve 10, so the movement of the diaphragm is transmitted to the valve without lost motion. This valve bears on the seat 11 which is provided with a narrow rectangular admission port leading to ½″ pipe tapped outlets *a* at either side of the base 3, one of which is to be connected by suitable pipe and flexible connection to the inlet C in the trip fitting casting 26 (Fig. 1, Instruction Pamphlet No. T. 5014) of the compressor, and the other plugged. The valve seat also has an exhaust port *c* (leading to the atmosphere) so located that the cavity in under side of valve 10 just spans the two ports. Thus when maximum pressure (45 lbs. per square inch for this type of equipment) is attained, the adjustment of the spring 8 is such that the

admission port is slightly uncovered and air from the pressure chamber D of the regulator passes to the chamber under the trip pistons 25 and, lifting the suction valves, cuts the pump out of operation. When the pressure in the main reservoir, and consequently that in the regulator chamber D, falls, the spring tension now being greater than the load on the diaphragm, forces the valve inwardly until the admission port is connected to the exhaust, when the air under the trip piston is released, the suction valves seat themselves and the pump is cut into operation.

Note that the narrow face of the slide valve must be placed over the admission port *a* when putting the regulator together.

Installation of the Regulator, D. R. E.

The Regulator should be fastened to a sill at a point as near the compressor as practicable. If the traps in the floor are large enough to permit fastening the regulator to one side of the opening without interfering with free access to the motor, it is an excellent location for it, being easy to get at for adjustment or cleaning. Three holes are supplied in the body 1 (Fig. 1) of the regulator, any one of which may be used for the ½" connection to the reservoir pipe, the others to be plugged. A union should be placed in this connecting pipe, near the regulator, to facilitate disconnecting it. The tee in the reservoir pipe should be placed as near the regulator and as far from the reservoir as practicable, so that the pump will be cut into action for every application of the brake.

In screwing the pipe into the body of the regulator

be sure the thread is not so long that the pipe enters far enough to strike the valve and prevent its free operation. Put a union in this pipe also, near the regulator for disconnecting. Before fastening the regulator in place, be sure that the slide valve 10 is tight on its seat 11; if such is not the case, open the regulator and clean thoroughly, putting a drop of valvoline oil on the seat and rubbing the valve on same; then without lifting the valve from its seat, replace the body, making sure that the valve is properly placed and that it's lug is in the groove between the flanges provided for them on the diaphragm guide 6, as described on page 3.

Oiling the Regulator, D. R. E.

Once a month, a few drops of good oil should be put in the Regulator to lubricate the valve, by removing the ½″ pipe plug. Twenty-eight degrees gravity West Virginia crude oil is the best for such purposes, as it does not gum, but engine oil may be used if the special oil cannot be obtained. Keep the Regulator adjusted to cut the pump out of action when 45 pounds pressure has been attained in the reservoir, neither more or less; the brake *must not* be permitted to remain in service with the regulator out of action and the safety valve taking care of the excess pressure. In such an event the pump is working all the time at a high pressure, causing excessive wear and danger of burning the bearings.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6930 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 018

January, 1904

Instruction Pamphlet No. T 5016

The Storage Air Brake System

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

The Storage Air Brake System.

This equipment is comprised of the following parts:

First—One or more Air-Storage Reservoirs in which compressed air is stored at a high pressure, and furnished to the brake system as needed.

Second—A Slide-Valve Reducing Valve, which automatically reduces the air pressure from that in the storage reservoirs to the regular pressure under which the brake apparatus operates.

Third—A Service Reservoir, in which the low pressure air is stored in sufficient quantity to properly operate the brake apparatus.

Fourth—A Brake Cylinder, the piston rod of which is connected to the brake levers in such a manner that when the piston is forced outward by the air pressure the brakes are applied.

Fifth—An Operating Valve, mounted at each controlling point of the car, by means of which the compressed air is admitted to or released from the brake cylinder.

Sixth—A System of Piping, which, with various small fittings, forms the connections between the above mentioned parts, and when trailers are used include flexible hose and couplings between cars.

Seventh—A Safety Valve, connected to the low pressure side of the air system, to prevent any possibility of accumulating an excessive pressure.

Eighth—Also often specified is a Chime-Whistle Set, operated by air pressure, as a warning of approach in place of a gong or bell.

Besides these, a central compressor plant is required where the air is compressed and delivered to the vari-

ous points at which the cars are to be recharged. These plants are special subjects to be considered by themselves, each requiring particular consideration in connection with local conditions, therefore, no description of them is given in this pamphlet.

Fig. 1 shows the arrangement of an Air-Storage Equipment on a double truck car which happens to be operated from one end only, but may be applied to a car operated at both ends equally as well. In this case air is stored in the two large storage reservoirs at a pressure of 300 pounds per square inch, and flows from them through the reducing valve to the service reservoir as it is needed.

The Slide-Valve Reducing Valve is identical in operation with the slide-valve feed valve used in connection with the motorman's brake valve, and described in Instruction Pamphlet No. T 5011. The design is modified so that it may be connected in the piping system instead of bolted to the brake valve, the top part being arranged for pipe-tapped openings on either side, and an arrow cast on the top to indicate the direction in which the air should flow.

The application of the brakes by admission of compressed air from the service reservoir to the brake cylinder is effected by opening either the small or the large port in the operating valve, thereby causing the piston in the cylinder to move outwardly, applying the brakes with a greater or less degree of force, depending upon which port was used, and the length of time it was open. In an ordinary service stop the small port is opened, which allows air to flow gradually from the reservoir into the brake

cylinder; but in an emergency stop the large port is opened, allowing a large amount of air to flow almost instantly into the brake cylinder. Thus the motorman is able to apply the brakes with such pressure, up to the maximum, and in as small a space of time as is desired. After admitting air to the cylinder, if the handle is placed in the position where all ports are closed, the air already admitted to the brake cylinder is retained there, thus holding the brakes applied. A further movement of the handle to the release position connects the brake cylinder with the atmosphere, permitting the air to escape, and thereby releasing the brakes. A graduated release of the brake may be obtained by permitting a portion of the air in the cylinder to escape and then returning the handle to the position where all ports are closed.

Installation of the Storage Air Brake System.

Fig. 1 shows the arrangement of the Storage Air Brake Equipment on a double-truck car. In this case the car is operated from one end only, but the arrangement is not materially altered where the car is operated from both ends, except that the piping connecting the operating valves with the service reservoir and brake cylinder would have to be continued to each end of the car and a high-pressure gauge should also be placed near each operating valve with its piping suitably arranged. This arrangement is the result of careful study and long experience, and we earnestly recommend that the parts of this equipment be connected in the same relative order as shown in this cut.

The Storage Reservoirs should be mounted similarly to the instructions given for main reservoirs in Instruction Pamphlet No. T 5005, and connected to each other in series in such a way that all the air is compelled to pass through both reservoirs before it reaches the brake system. In this way all moisture and foreign matter carried into the pipes at the charging point will be deposited in either one or the other of these reservoirs. A $\frac{3}{8}''$ pipe should connect the second reservoir to the High-Pressure Gauge in the vestibule, so that the motorman may know, by means of this gauge and that connected with the operating valve, the pressure at all times in any part of the brake system.

The Slide-Valve Reducing Valve should be set to reduce from the storage-reservoir pressure to 60 pounds per square inch for the Straight-Air Equipment. It should be placed in the pipe connecting the second storage-reservoir to the service reservoir, so that the air will flow in the

direction indicated by the arrow on the top of the Reducing Valve. A cut-out cock should be placed between it and the storage reservoir, to cut off the high pressure supply to the brakes if necessary.

To restore the pressure in the storage reservoirs, connection must be made with the High-Pressure supply at a charging point. This is done by having on each side of the car, a charging coupling similar to the head in the hose couplings between the cars, connected by a pipe to the first storage reservoir, to which coupling may be coupled a hose connection from the main high-pressure supply system at the charging point. Between the charging-coupling pipe and the storage-reservoir should be placed a check valve, and in the charging-coupling pipe just back of each fitting should be placed a cut-out cock as shown in Fig. 1.

In figuring out the best possible locations for the reservoirs, brake cylinder, etc., due regard must be had to the apparatus already under the car or to be placed there, as well as to the fact that those parts requiring inspection and care should be placed in the most accessible locations to facilitate inspection and maintenance.

After these locations have been settled upon we would recommend that the apparatus be installed according to the instructions given in the instruction pamphlets mentioned on the last page of this pamphlet.

Instructions for Operating the Straight-Air Brake.

As the Operating Valve has notches which mark the position of the handle for the various positions of the valve, it is very easy for one to operate the brake with certainty the first time, but smooth, quick and accurate stops are only made after a little practice. The operating valve handle must always be inserted at the lap position where the slot in the body is enlarged for that purpose, and withdrawn at the same point when changing from one end of the car to the other. When the handle is in lap position, as indicated by the deep notch, the valve is so placed that air can neither pass into nor out of the brake cylinder. Moving the handle of the O. V. J. valve to the end of the slot toward the left places the valve in full release, while a movement to the right, as far as the small notch, opens the small port, and a further movement to the right end of the slot opens wide the large port. A good deal of compressed air will flow through a small opening in a short time, so that in order to make a light application of the brakes, move the handle to the small notch, and then quickly back to the deep notch or lap, thus the air that has been admitted to the cylinder is retained there, holding the brakes applied. To partially release the brake reduce the pressure in the cylinder by turning the handle to the release position at the left end of the slot, and almost immediately returning it to lap, thus allowing a portion of the air to escape from the cylinder.

The quickest stop obtainable is made by applying, throughout the stop, the greatest pressure possible to the wheels without causing them to slide on the rails, and the higher the speed the greater the pressure that may be ap-

plied without danger of sliding. Thus it is evident that in order to make a quick stop apply full pressure at once, and release it gradually as the speed falls; this method will also give a smooth stop, as the rapid reduction of speed at the end of the stop, which throws passengers, is avoided. Therefore, in making a service stop, admit twenty-five or thirty pounds of air pressure to the brake cylinder quickly at the beginning of the stop by partially opening the large port, and release it little by little as the speed drops, retaining about ten pounds in the cylinder till the car stops. A little experience will show the distance required in which to make a stop from a given speed so that all stops will be made quickly, smoothly and with but one application of the brake. A succession of applications and releases while making a stop imparts a very disagreeable motion to the car, is most wasteful of compressed air, and reprehensible in every respect. For the emergency stop admit full pressure (about sixty pounds) immediately, without even waiting till the controller is turned off, then apply sand and release a little of the pressure as the speed drops.

Upon receiving the signal to go ahead, turn the handle to the release position before turning on the electric power. When descending a grade a beginner generally makes the mistake of putting the brake on too hard at the start; it cannot be expected that the instant the brake is applied the car will take the speed desired; make an easy application at first, hold the handle at "Lap" and give the car time to feel the effect of the brake, then if the speed is still too high, let in a *little* more air; repeat the operation as often as necessary until off the grade, in case it is a long one.

When leaving a car, always set up the hand brake, as some one might tamper with the cut-out cocks. Before starting from the car barn, be sure all cocks are properly set and that there is a good supply of air in the reservoir. Insert the handle in its socket in the operating valve and throw it around to emergency, then back to release, to see that it works freely. Try the air brake both in "service" and "emergency" to make sure that it has not been left improperly connected, etc. After this trial and as long as proper pressure is maintained the brake may be relied upon to perform its duty.

TRAILERS—Care must be taken in making up trains, that all hose couplings are thoroughly united so that the air will apply throughout the entire train. All the cut-out cocks must be opened, except those on the rear of the last car and on the front of the motor car, which must be closed. In uncoupling the cars close the cocks and disconnect the hose before pulling the drawbar pin.

The air brake is essentially a labor saving device for the motorman, and it is scarcely necessary to ask for his coöperation in the use and care of it. Its success and general adoption for fast and heavy street railway service depends very much on his interesting himself in its use, and having an intelligent understanding of the functions of the various parts, that he may readily notice when anything about them is not working properly, and report the trouble before it becomes serious. Like the other apparatus of a street car, the air brake will not operate indefinitely without attention, and the old proverb of "a stitch in time saves nine" applies in this case as in all others.

The following Instruction Pamphlets, added to this one, go to make up a complete set as applied to the Storage Air-Brake Equipment:

	Instruction Pamphlet
Reservoirs	No. T 5005
Slide-Valve Reducing Valve	T 5011
Brake Cylinder	T 5006
Operating Valve	T 5007
Piping	T 5008
Chime-Whistle Set	T 5009

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6930 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 019

January, 1904

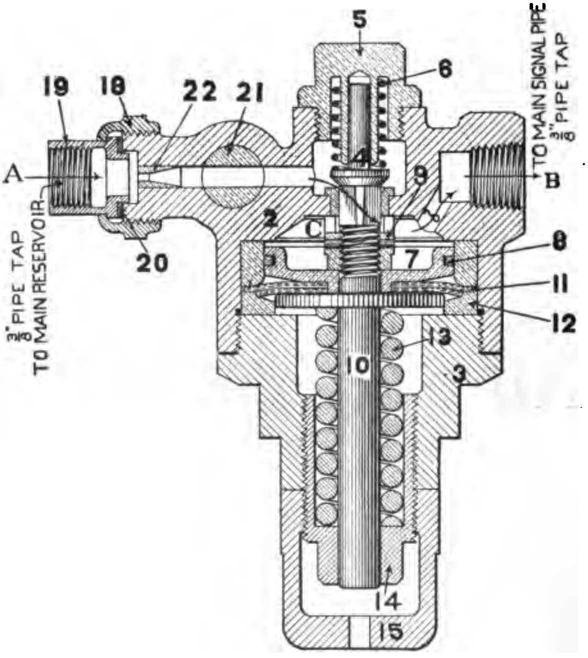
Instruction Pamphlet No. T. 5017

The Train Air-Signal System

WESTINGHOUSE TRACTION BRAKE CO.,

26 Cortlandt Street,
New York, U. S. A.

FIGURE 1.



PRESSURE REDUCING VALVE.

The Train Air-Signal System.

Fig. 4 shows the general arrangement of the parts of the Train Air-Signal System upon a motor-car and trailer; a more detailed description of the arrangement will be unnecessary. This Plate is a diagrammatic illustration of the general arrangement only.

Description of Parts.

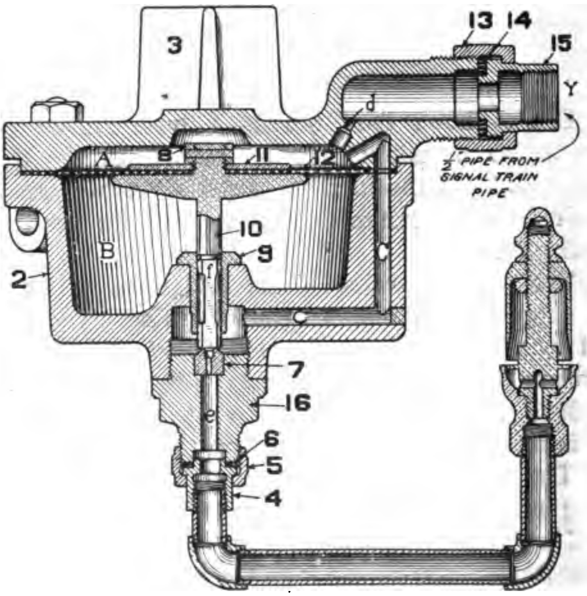
The Reducing Valve.

Fig. 1 shows the Reducing Valve. An air pressure of 40 pounds should be carried in the signal system, and it is the function of this valve to reduce the main-reservoir pressure to this standard for use in the signal pipe.

The reducing-valve piston and stem 7 and 10, are supported by the tension of spring 13 and lowered by the pressure in chamber C, when sufficient to overcome the tension of the spring; 4 is the supply valve, which is moved from its seat by the stem of piston 7 and is seated by the tension of spring 6.

The tension of spring 13 is so adjusted, by regulating nut 14, that an air pressure of 40 pounds in chamber C is required to depress piston 7. When the valve is in the position shown, air from the main reservoir enters through the pipe connected at A, and, as indicated by the arrows, flows through chamber C into the signal pipe connected at B. As soon as signal-pipe pressure reaches 40 pounds, the pressure in chamber C forces piston 7 down and allows valve 4 to seat. No more air can then enter the signal pipe until, through leakage or otherwise, the signal-pipe pressure becomes reduced so that spring 13 may raise piston 7 to unseat supply valve 4.

FIGURE 2.



THE AIR-SIGNAL VALVE AND WHISTLE.

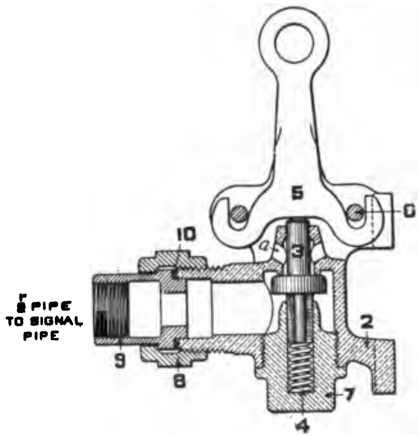
THE SIGNAL VALVE.

In the Signal Valve (Fig. 2), the two compartments A and B are separated by diaphragm 12, and diaphragm stem 10, secured thereto, extends through bushing 9, its end acting as a valve on seat 7 of cap nut 16, above passage *e*. Diaphragm stem 10 fits bushing 9 snugly for a short distance below its upper end, to where a peripheral groove is cut in the stem, below which it is milled in triangular form. The air enters the signal valve at Y and flows through port *d*, changing chamber A, and through passage *c*, passing stem 10, into chamber B. The whole being charged, a sudden reduction of pressure in the signal pipe reduces the pressure in chamber A, above diaphragm 12, and the unreduced pressure in chamber B, acting upon its lower surface, forces diaphragm 12 upward and momentarily permits air to escape from the signal pipe and chamber B to the whistle, through a pipe attached at X. The resulting blast of the small signal whistle, located in the vestibule, is a signal to the motorman. The same sudden reduction of pressure also operates upon the reducing valve to cause air from the main reservoir to flow into the signal pipe and restore the pressure. Equilibrium of pressure quickly occurs in chambers A and B, and the valve at the end of stem 10 returns to its seat.

THE CAR DISCHARGE VALVE.

The Car Discharge Valve (Fig. 3) is usually located outside of the car in the vestibule, above the door and opposite the opening through which the signal cord passes. A branch pipe extends from the main signal

FIGURE 3.



THE CAR DISCHARGE VALVE.

pipe to the Car Discharge Valve, and in this pipe is placed a one-half-inch cock, by means of which the valve on the car may be cut out when desired.

Each pull upon the signal cord causes lever 5 to open valve 3, permitting a small quantity of air to escape from the signal pipe, and thereby causes a signal to be transmitted to the motorman, through the operation of the Signal Valve and Whistle, as previously described.

GENERAL.

Inasmuch as any discharge of air from the signal pipe causes the air whistle to sound, it is obvious that all air-signal pipes should be perfectly tight, so that signals may not be incorrect and may not occur when not intended.

An interval of three seconds, in which to assure recharging of the signal pipe, should be permitted to elapse between successive discharges of air from the car discharge valve. Upon trains of exceptional length, this time interval should be slightly increased.

Wherever possible, the Reducing Valve and Signal Valve should be so located inside the car that they will be protected from both cold and excessive heat.

The signal-pipe air strainer upon the car should always be located as indicated in Fig. 4.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 020

January, 1904

Instruction Pamphlet No. T 5018

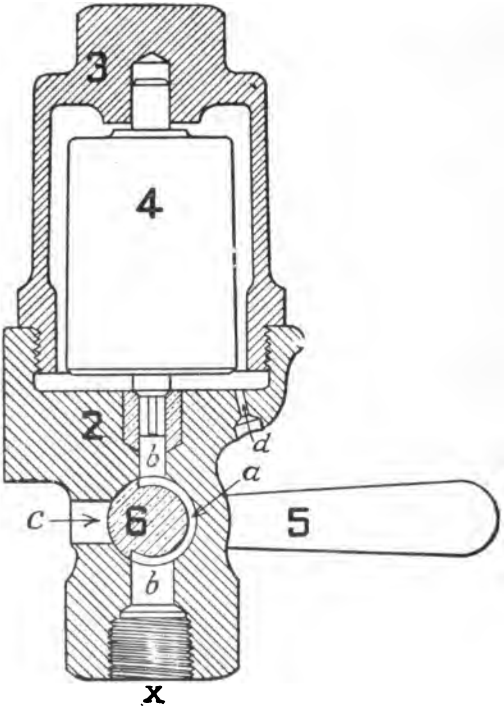
The Pressure-Retaining Valve

WESTINGHOUSE TRACTION BRAKE CO.

26 Cortlandt Street,

New York, U. S. A.

FIGURE I.



PRESSURE-RETAINING VALVE

The Pressure-Retaining Valve.

The Pressure-Retaining Valve (Fig. 1) is used in steam railway practice almost exclusively upon freight cars, except in districts where very heavy grades are encountered, where it is also used upon passenger cars. As heavy and long grades are very common in electric traction service, this simple device is an important adjunct to the quick-acting triple valve under such conditions.

With the Pressure Retaining Valve in operation, a certain portion of the brake-cylinder pressure may be retained to retard the acceleration of the train while the motorman is recharging the auxiliary reservoirs. The pressure of the air reserved in the cylinder is determined by weight 4, which, in the standard valve, is capable of retaining a pressure of fifteen pounds per square inch, which has been found by experience to furnish sufficient retarding power to prevent a too rapid acceleration of the train speed, and to thus provide sufficient time to enable the motorman to recharge the train upon heavy grades.

When handle 5 points downward, the valve is inoperative for retaining pressure. If the motorman release the brakes when the retaining-valve handle is turned down, the air from the brake cylinder discharges through the triple valve into the retaining-valve pipe, (which is screwed into the triple-valve exhaust port), through the pipe to the retaining valve, which it enters at *X*, and through ports *b, a* and *c* to the atmosphere. If handle 5 be turned horizontally, as shown in Fig. 1, the air is discharged from the brake cylinder through the triple valve, retaining-valve pipe, and ports *b, a* and *b,* as before; but now, port *c* being closed, it must lift weighted valve 4 and pass

to the atmosphere through the restricted port *d*. When the brake-cylinder pressure has become reduced to fifteen pounds, the weighted valve becomes seated, and the remaining fiften pounds is retained in the brake cylinder until handle 5 is turned down.

The Pressure-Retaining Valve has nothing whatever to do with applying the brake or admitting air into the cylinder; it simply locks in the brake cylinder fifteen pounds of the air pressure that has been supplied through the triple valve, and then only if handle 5 has been placed in the horizontal position, shown on Plate 41, before the motorman increases train-pipe pressure to release the brakes.

The Improved Pressure-Retaining Valve (Fig. 1) has a peripheral cavity extending half way round the key, through which the air has to pass to reach the weighted valve, when the device is in operation. This modification is designed to prevent obstruction of the ports, which sometimes occurred with the old form of construction, in which the cavity was replaced by a slot extending through the key.

Failure of the Pressure-Retaining Valve to hold air in the brake cylinder is generally due to a leak in the connecting pipe, a frequent seat of trouble being at the union: it may also be due to a leak in the brake cylinder or in the Retaining Valve, but seldom in the latter.

The structure should stand vertically; there should be no obstruction to the removal of the cap; it should be so located as to be free of access when the train is in motion; it should be cleaned, but not oiled, every time the remainder of the air-brake equipment receives that attention; both it and the connecting pipe should be well

secured; a good rubber gasket should be used in the union, and a little flexibility should be provided in the pipe leading to it from the triple valve.

INSTALLATION.

When the Pressure Retaining Valve is used, it should be secured in a vertical position to the end of the car on the vestibule wall in an inconspicuous place, and connected by ⅜″ pipe to the exhaust opening in the side of the triple valve body. It's position should be such that the handle which comes through the vestibule wall should be within easy reach of the motorman or conductor.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 021

January, 1904

Instruction Pamphlet No. T 5019

Piston Travel

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

Piston Travel.

The following are commonly used terms and their definitions.

STANDING TRAVEL—The distance the piston is forced outward in applying the brake upon a car when not in motion.

RUNNING TRAVEL—The distance the piston is forced out in applying the brake upon a car when in motion. The running travel is always greater than the standing travel, the increase being due to slack in loose-fitting brasses, to the shoes pulling down upon the wheels, to play between boxes and pedestals, and to everything of a similar nature that increases lost motion in the brake rigging under the influence of the motion of the car.

FALSE TRAVEL—An excessive travel momentarily occurring while a car is in motion; it is due to unevenness of the track, or to some unusual temporary strain.

The brake-cylinder pressure resulting from a given train pipe reduction is greater with a short than with a long piston travel.

A piston travel of 8 inches results in a brake-cylinder pressure of about 50 pounds, in a full service application of the brake. Inasmuch as running travel is generally about one and one-half inches greater than standing travel, the standing travel should be 6½ inches to secure this result while running. An automatic slack adjuster is the only means of adjusting piston travel so closely; but, where one is not employed, good practice customarily requires that the standing piston travel on cars should be kept as close as possible to 6 inches.

A 10-pound reduction of train-pipe pressure results in a brake-cylinder pressure more than 50 per cent. greater with a 4-inch than with an 8-inch piston travel.

In rapid transit or interurban service, where cars are operated in a train, if the piston travel varies throughout the train, a sufficient train-pipe reduction must be made to fully apply the brakes having the longest piston travel; in releasing, the increasing train-pipe pressure will force the triple-valve piston on the car with an 11-inch piston travel to release position first, the one on the car with a 10-inch travel next, and so on down, those with the shortest travel being applied with the greatest force and releasing last.

It will be clear, therefore, that satisfactory operation can only be secured by uniformity of piston travel upon all cars in a train. If the piston travel be unnecessarily long, the brake-cylinder pressure is thereby reduced and the efficiency of the brakes correspondingly impaired; in addition, a greater quantity of compressed air is consumed in brake applications than would otherwise be necessary, thereby entailing greater demands upon the air compressor, with correspondingly increased wear and tear. If the piston travel be *too* short, it is apt to be accompanied by dragging of the brake shoes upon the wheels while the brakes are released, and by too high a brake-cylinder pressure, with an accompanying liability of sliding wheels, when the brakes are applied. The proper piston travel is generally that with which there is just sufficient brake-shoe clearance when the brakes are released. As already stated, a standing piston travel of about six inches has been found to customarily meet this requirement. Special conditions undoubtedly occur in certain cases under which a uniformly shorter piston travel may be very advantageously employed; in such cases, a modification of the brake leverage may perhaps

also be desirable, on account of the high cylinder pressures so resulting.

In adjusting piston travel on rolling stock for freight service, it should be carefully noted whether the brake beams are so hung as to be at the same height above the rail when the car is light as when loaded, or are so hung that they are lowered when the car springs are compressed through loading the car and are raised when the load is removed. If the brake beams are always at the same height above the rail, it is safe to adjust the piston travel when the car is either light or loaded; but if the height of the beams varies according to the load in the car, it is best, whenever possible, to adjust the piston travel when the car is light. If the travel be adjusted when the car is loaded, and the brake shoes are consequently in their lowest position, wheels are very likely to be slid after the car is unloaded, as, the shoes being thereby raised, the shoe clearance becomes less and the piston is not required to travel so far to bring the shoes up to the wheel tread. As a consequence, the piston travel may become too short and, the car then being light, flat wheels are likely to result. If the piston travel be adjusted when the car is light, the shoe clearance becomes increased as the load causes the car to settle. This results, of course, in lower brake-cylinder pressures and, consequently, in inferior brake efficiency; but the danger of injurious wheel sliding is avoided.

Piston travel should be adjusted as uniformly as possible throughout a traction system, in which case each brake will more nearly do its share of work when in a train, there will be fewer flat wheels whether operating in trains or singly, and smoother braking will result in all cases.

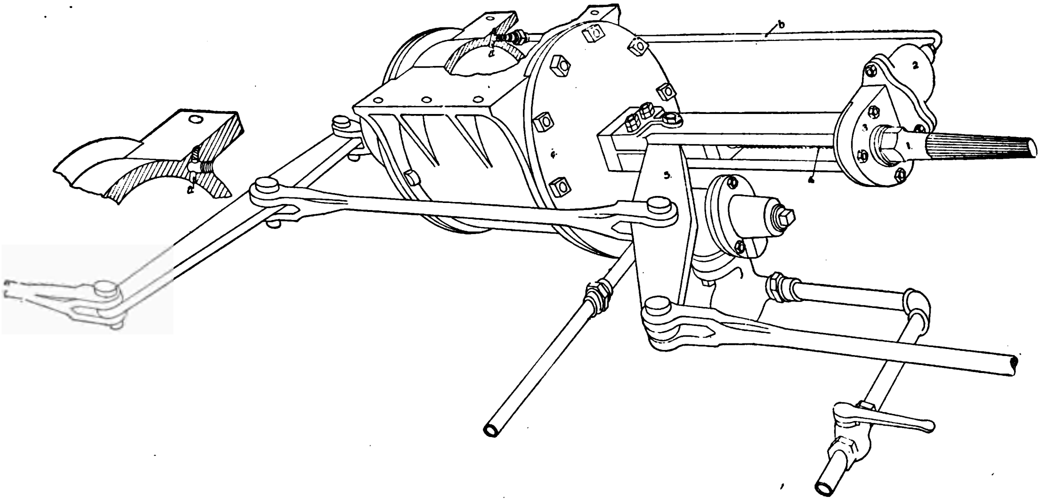
January, 1904

Instruction Pamphlet No. T 5020

The Automatic Slack Adjuster

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

FIGURE 1.



AUTOMATIC SLACK ADJUSTER.

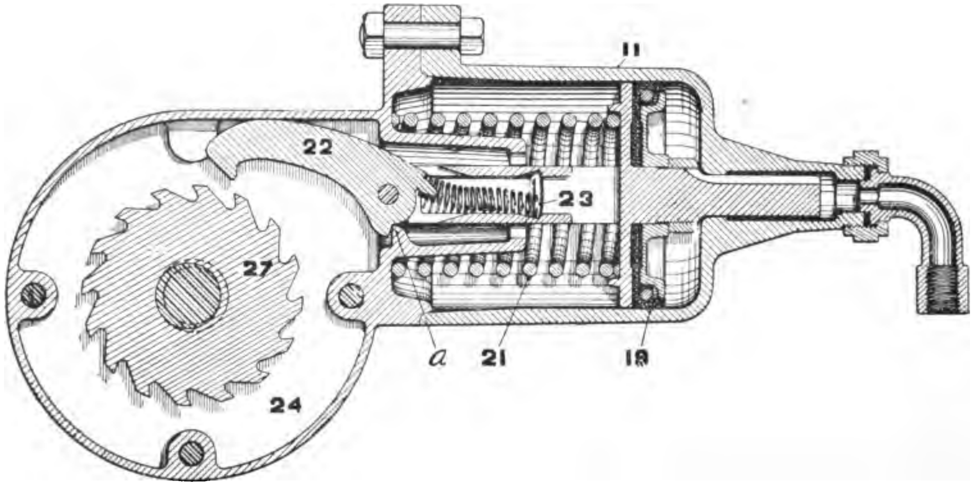
The Automatic Slack Adjuster.

The Automatic Slack Adjuster is a simple mechanism, by means of which a predetermined piston travel is constantly maintained, compelling the brakes of each car to do their full quota of work—no more and no less—thus securing from the brakes their highest efficiency, without the flat wheels which are likely to accompany a wide range of piston travel.

This device establishes the running piston travel; that is, the piston travel occurring when the brakes are applied while the car is in motion; and, since this is the time during which the brakes perform their work, the running travel is the important one. Hand adjustment necessarily relies upon the standing travel, and it is only coarsely graded, at best, by the spacing of the holes in the dead-lever guide.

The Automatic Slack Adjuster is illustrated on Figs. 1 and 2, and its operation is very simple. The brake-cylinder piston acts as a valve to control the admission and release of brake-cylinder pressure to and from pipe *b* (Fig. 1) through port *a* in the cylinder, this port being so located that the piston uncovers it when the predetermined piston travel is exceeded. Whenever the piston so uncovers port *a*, brake-cylinder air flows through pipe *b* into slack-adjuster cylinder 2, where the small piston 19 (Fig. 2) is forced outward, compressing spring 21. Attached to piston stem 23 is a pawl, extending into casing 24, which engages ratchet wheel 27, mounted within casing 24 upon screw 4 (Fig. 1). When the brake is released and the brake-cylinder piston returns to its normal position, the air pressure in cylinder 2 escapes to the atmosphere through pipe *b*, port *a* and the non-pressure head of the brake cylinder, thus

FIGURE 2.



AUTOMATIC SLACK ADJUSTER.

permitting spring 21 to force the small piston to its normal position. In so doing, the pawl turns the ratchet wheel upon screw 4, and thereby draws lever 5 slightly in the direction of the slack-adjuster cylinder, thus shortening the brake-cylinder piston travel and forcing the brake shoes nearer the wheels. As the pawl is drawn back to its normal position, a lug on the lower side strikes projection *a* (Fig. 2) on the cylinder, thus raising the outer end of the pawl, disengaging it from the ratchet wheel, and permitting the screw to be turned by hand if desired.

To apply new shoes, turn casing 1 to the left, thus moving lever 5 toward the position shown on Plate 44, until sufficient slack is introduced in the brake rigging. To bring the shoes closer to the wheels and shorten the piston travel, turn casing 1 to the right.

The screw mechanism is so proportioned that the piston travel is reduced only about 1/32 of an inch in each operation, which removes danger of unduly taking up false travel.

Port *a* should be drilled as indicated on Fig. 3.

To avoid the necessity of a bracket to support the adjuster, a special cylinder head, provided with a suitable lug, has been designed for that purpose, and is now furnished with car cylinders of the separated type, unless other styles be specified. (See Instruction Pamphlet No. T. 5006.)

After the slack adjuster has been applied and the pipe tested for leaks, sufficient slack should be introduced in the brake gear, by means of the adjuster, and an entire new set of shoes applied. The slack should then be taken up, by turning casing 1 to the right, until the standing piston travel is from six to six and one-half inches, care

being exercised to distribute the slack equally on both trucks by giving about the same angle to the dead levers. When the brake gear of a car, having a proper total leverage, is thus equalized, the adjuster will maintain a constant piston travel until a full set of shoes has worn out, without any necessity of changing the position of the dead levers.

The dead and live levers should each have such an inclination, when new shoes are applied to the wheels, that they shall have corresponding inclinations in the opposite direction when the shoes have become worn out. The proper inclination of the dead lever is established by securing the upper pin at a distance half the wearing thickness of the shoe nearer a vertical plane through the axle than that of the brake-beam-clevis pin from the same plane, when new shoes are applied to the wheels. The proper inclination of the live lever is then secured by making the connecting rod or strut between the levers shorter, if outside hung-brakes, or longer, if inside hung-brakes, than the distance between the two brake-beam-clevis pins, by the wearing thickness of a shoe, the distance between the two brake-beam pins being measured when the shoes are all new and applied to the wheels.

If the piston travel become too short, it will be found that either some of the slack in the brake rigging has been taken up by the hand brake, where the two work in opposition, or the dead levers have been moved.

If the piston travel is found to be too long, when the small pipe leading to the adjuster cylinder is free from obstruction and the packing leather in the adjuster cylinder is free from leakage, it is more than probable that the slack has been taken up through an application and only partial release of the hand brake, and subsequent full re-

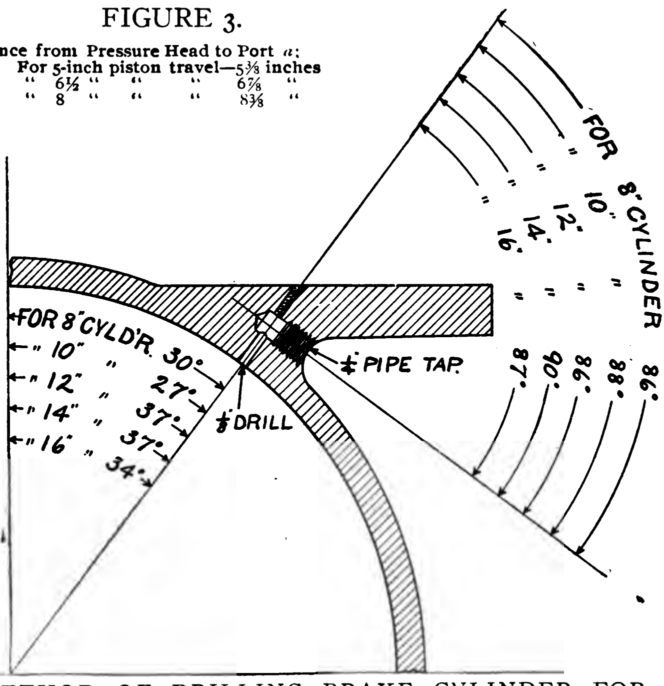
lease occurred only after the shoes had had time to wear more or less.

The best results are obtained by the use of copper pipe from the brake cylinder to the adjuster cylinder, since this pipe is more flexible and does not corrode. It should always be firmly secured.

Every time the brake cylinder is cleaned and oiled, the slack-adjuster cylinder should obviously receive the same attention; and, after each cleaning and oiling, a test of the brakes should also include one of the adjuster.

FIGURE 3.

Distance from Pressure Head to Port *a*:
For 5-inch piston travel—5⅜ inches
" 6½ " " " 6⅞ "
" 8 " " " 8⅜ "



METHOD OF DRILLING BRAKE CYLINDER FOR SLACK ADJUSTER PIPE CONNECTIONS.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 023

January, 1904

Instruction Pamphlet No. T 5021

Brake Inspection and Maintenance

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass,	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	1545 Railway Exchange Building
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
Los Angeles, Cal.	621 Trust Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. .024

January, 1904

Instruction Pamphlet No. T 5022

The School of Instruction

WESTINGHOUSE TRACTION BRAKE CO.,

26 Cortlandt Street,

New York, U. S. A.

School of Instruction.

The steam railroads have for many years realized the importance of arranging classes of instruction on the air brake for their trainmen and employees coming in contact with its use or maintenance. Almost every steam railroad has its own instruction car, fitted up with apparatus and piping representing a complete train, which travels from point to point on the system giving demonstrations of the use and availability of the brake under all conditions.

Many traction systems have a school of instruction for their motormen, where a dummy truck is set up having upon it a motor, or motors, controller, and the various electrical devices for getting the car into motion. But very seldom do these dummy trucks ever have any braking apparatus outside of the ordinary hand brake. In this way the instruction is only half done. The car is in motion, but how about stopping it? Is it not just as important a part of the motorman's duties to know how to stop a car as to start it? In fact, it is more so, for in case of emergency, when the lives of many persons may be in danger, the vital question is to stop the car and not to start it. Those moments when the motorman must act most quickly, unerringly, and even instinctively, are when he is called upon to use the brake to its full efficiency. He must therefore know just what that efficiency is and how to obtain it, and for that reason it is indispensable that he should be made thoroughly acquainted with its details and the purposes of them.

Another point which traction road managers should readily appreciate, is that the braking equipment, although not so expensive as the electrical equipment, still represents an outlay of capital for machinery, which

should be maintained just as carefully and just as thoroughly as any of the rest of the mechanical equipment of the road. *No mechanism* of any value can last long if in the hands of some one who knows little or nothing about it, whereas the small cost of an instruction outfit is scarcely noticeable in comparison with the depreciation in the value of the brake apparatus when used without such instruction.

Also, the type of man who to-day fills the position of motorman is of a far more roving disposition than his confrere on the steam railroads. He is not nearly so likely to stay in one place for any length of time, and consequently the need of training and schooling new men is, at the present time, practically a constant one.

By a school of instruction, we do not mean an arrangement where some one may stand before a class and talk on the use of the apparatus; we mean to imply that such a class should have before it an actual working model which will duplicate as nearly as possible the car itself, and which will be supplied with a full set of apparatus to be operated under as nearly the same conditions of actual practice as it is possible to make it. Also that instruction on the brake should be given regularly by some one who is thoroughly acquainted with the construction and operation of that apparatus, and who can give ocular demonstration of its use and how to handle and take care of it.

This course of instruction should include the necessity of each man being placed upon the dummy and made to operate it under various supposed conditions as given by the instructor. This should be done till he has shown himself thoroughly familiar with the apparatus, and competent to handle it alone.

FIGURE 1.

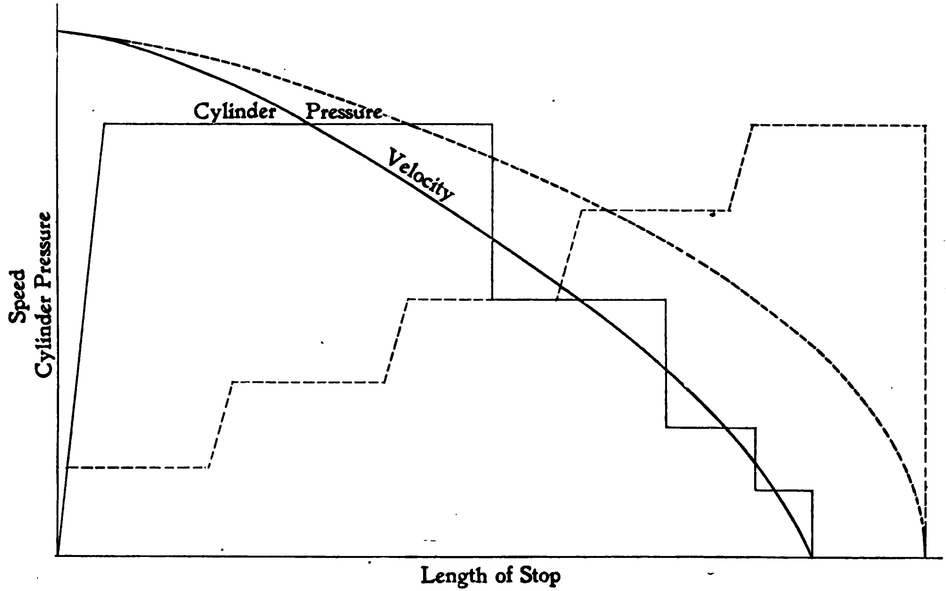


DIAGRAM SHOWING PROPER AND IMPROPER USE OF AIR IN MAKING A STOP.

Besides the mere mechanical operation of the brakes, such instructions regarding the handling of them should be given as correspond with those in Instruction Pamphlets Nos. T 5001 and T 5010, and the reasons for them. For example: it is a common thing for a motorman, in making a stop, to let into the cylinder about 5 pounds first, then afterwards at frequent intervals, 5 pounds more, till, when the car comes to a stand still, there is a large pressure in the cylinder. Invariably during such a stop, the passengers get a decided shaking up. It becomes the duty of the instructor, therefor, to show that, as the speed decreases, the cylinder pressure necessary to obtain a certain braking power becomes less also, consequently the above mentioned proceeding is exactly wrong. The diagram in Fig. 1, will make this more clear. The dotted line represents the results due to a serial application as above described; beginning with a small pressure and ending with a large one in the cylinder, the decreasing velocity will follow approximately the dotted curve. If, however, this pressure were made to follow the full line, giving a high initial pressure and gradually reducing it as the speed decreased, the stop would follow closely the full curve and be much smoother and quicker, and, as shown, a considerable gain in the length of stop would result.

Such points as this, and many others, can most readily be brought home to the motorman, by a well equipped and carefully carried on School of Instruction, and we most urgently recommend that one be instituted wherever possible. It's cost of installation and maintenance is practically negligible and trifling, and will be many times made up in the better maintenance of the brake equipment which is sure to result.

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 025.

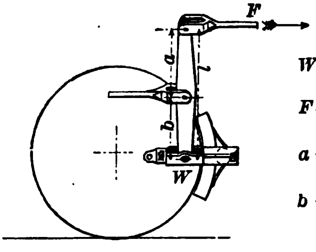
January, 1904

Instruction Pamphlet No. T 5023

Leverage
and
Foundation Brake Gear

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

FIGURE I.



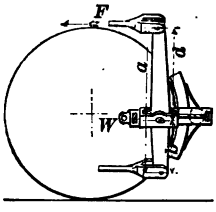
$$W = \frac{F \times a}{b}$$

$$F = \frac{W \times b}{a}$$

$$a = \frac{W \times b}{F} \quad \text{or} \quad a = \frac{W \times l}{F+W}$$

$$b = \frac{F \times a}{W} \quad \text{or} \quad b = \frac{F \times l}{F+W}$$

FULCRUM BETWEEN APPLIED AND DELIVERED FORCES.



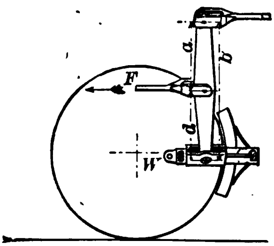
$$W = \frac{F \times a}{b}$$

$$F = \frac{W \times b}{a}$$

$$a = \frac{W \times b}{F} \quad \text{or} \quad a = \frac{W \times d}{W-F}$$

$$b = \frac{F \times a}{W} \quad \text{or} \quad b = \frac{F \times d}{W-F}$$

DELIVERED FORCE BETWEEN FULCRUM AND APPLIED FORCE.



$$W = \frac{F \times a}{b}$$

$$F = \frac{W \times b}{a}$$

$$a = \frac{W \times b}{F} \quad \text{or} \quad a = \frac{W \times d}{F-W}$$

$$b = \frac{F \times a}{W} \quad \text{or} \quad b = \frac{F \times d}{F-W}$$

APPLIED FORCE BETWEEN FULCRUM AND DELIVERED FORCE.

Leverage.

In every calculation required to determine the proper proportions of brake levers, or to determine the forces operating upon different pins, two forces and two distances are involved: one force is that which may be regarded as applied at one of three pins, and the other force as that delivered at another of the pins, while the remaining pin becomes the "fulcrum"; the two distances involved are those between the fulcrum pin and the pins at which the two forces are applied and delivered, respectively. In every case, the product of the force applied at one pin and its distance from the fulcrum pin is equal to the product of the force delivered at the other pin and its distance from the fulcrum pin. If the applied force be designated by F and its distance from the fulcrum pin by a, and if the delivered force be designated by W and its distance from the fulcrum pin by b, then $F \times a = W \times b$. When the applied force F and the distances a and b are all known, the delivered force $W = \frac{F \times a}{b}$. If the force W, which must be delivered, and the two distances a and b are known, the force that must be applied is $F = \frac{W \times b}{a}$. Similarly, if both the applied force F and the force W that must be delivered are known, together with the distance of one of the forces from the fulcrum pin, the other distance is $a = \frac{W \times b}{F}$ where b is the known distance, or $b = \frac{F \times a}{W}$ where a is the known distance.

It is to be understood, of course, that if a force is operative at any one of the three pins, forces must also

be operative at both of the other two pins; but the force exerted at the middle pin of a straight lever is always equal to the sum of those at the other two, and opposite in direction. The force at any one of the three pins may, in such calculations, be regarded as the applied force, and that at either of the other two may be treated as the delivered force, the remaining pin becoming the fulcrum in that case.

There thus appear to be three different sets of conditions, depending upon the relative position of the fulcrum pin; but the same rules and formulæ apply to each. The three cases are illustrated, as applied to the truck brake lever, in Fig. 1. In each of the three cases, the formulæ for determining the applied and delivered forces and their distances from the fulcrum pin are given, and it will be observed that the formulæ are precisely the same in all three cases, except as affected by the following considerations.

It sometimes occurs that, when the middle pin is the fulcrum pin, the applied and delivered forces at the end pins are given, but the only distance known is that between the end pins. In that case, neither distance a nor b, but only their sum, is known. In such a case, it is necessary to proceed as follows: Let the length of the lever—or the distance between the end pins—be represented by l, the force at the middle pin equals $F + W$, then treating for the moment the pin at the upper end as a fixed point or fulcrum, we have $(F + W)a = W \times l$, therefore, $a = \frac{W \times l}{F + W}$. Considering the lower end as the fixed point we have $(F + W)b = F \times l$, therefore, $b = \frac{F \times l}{F + W}$ If a and b as determined by the above

formula are found to equal l when added together, the calculations must be correct.

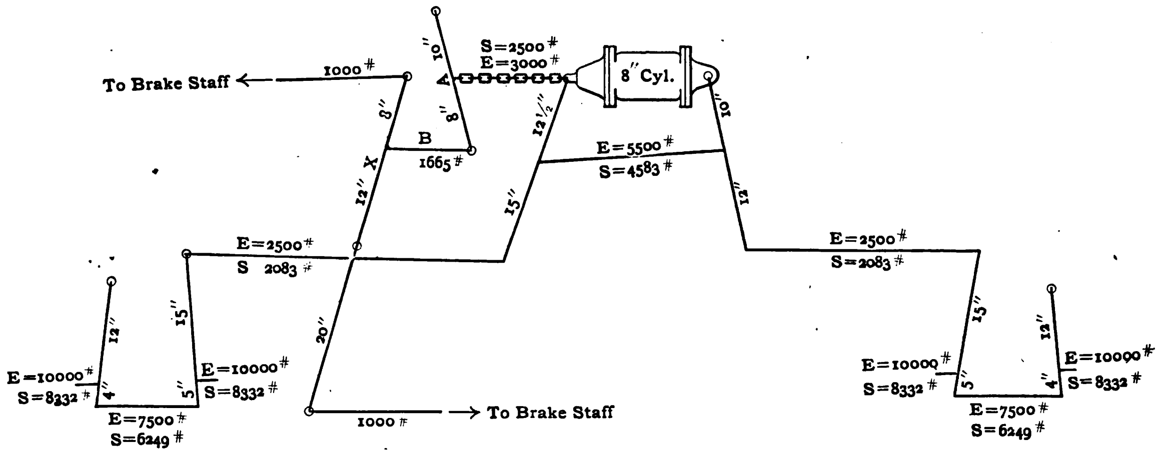
Again it may occur that both the applied force F at one pin and the force W that must be delivered at another pin are known, but the only additional information is the difference between the distances a and b, the fulcrum being an end pin. Let d represent the difference between the distances a and b. Two cases arise. In one case a is greater than b by d inches. Then the force at the lower pin equals $(W - F)$ and, with the top pin as the imaginary fixed point, we have $(W - F)a = W \times d$, or $a = \frac{W \times d}{W - F}$, and with the middle point fixed, $(W - F)b, = F \times d$, or $b = \frac{F \times d}{W - F}$. The check is that the calculated value of a must equal the sum of d and the calculated value of b.

In the other case a is less than b by d inches, and the force at the upper pin is equal to $F - W$, and with the middle pin as the imaginary fixed point, we have $(F - W)a = W \times d$, or $a = \frac{W \times d}{F - W}$. With the lower pin fixed, $(F - W)b = F \times d$, or $b = \frac{F \times d}{F - W}$. The check is that the calculated value of a must be equal to the calculated value of b less d inches.

It is of the utmost importance that the same units of force and distance be preserved throughout the calculations, all forces being preferably expressed in pounds and all distances in inches. It is equally important to remember that each reference to the distance between pins invariably means the distance from center to center of pins or of pin holes.

The foundation brake rigging of a car naturally di-

FIGURE 2.



Light Weight of Motor-Car, 40,000 pounds: Braking Power, 40,000 pounds, or 100 per cent.

E indicates forces in Emergency Applications and S indicates forces in Full Service Applications.

vides itself into to parts, viz.: the levers, rods, shoes, etc., on the trucks, and the levers, rods, etc., on the car body. When installing the air brake on a car in electric traction service it will generally be found that the parts on the truck, being incorporated in the design of same, cannot be modified and that the adaptation for the air brake will have to be made in the body levers.

The following practical example will illustrate the method of employing the formulæ above given. It is required to apply the air brake to a motor-car having a four motor equipment, and whose light weight is 40,000 pounds. The general construction of the brake gear is to be as shown in Fig. 2. The live truck lever supplied with the truck is 20 inches long, and is secured to the brake beam at a point 5 inches from the lower end. The connection to the dead lever, is at the lower end, and is consequently 20 inches from the upper end. Owing to the inertia of the rapidly revolving armatures it is quite safe, when considering four motor cars, to apply to the wheels a total maximum braking force equal to 100% of the weight of the empty car. As this car weighs 40,000 pounds, the pressure from the four brake beams upon the wheels must be 40,000 pounds, or 10,000 pounds per beam. The delivered force (W) at the middle hole of the live lever must, therefore, be 10,000 pounds; the lower pin is the fulcrum; the distance (b) from the fulcrum to the delivered force is 5 inches, and the distance (a) from the fulcrum to the applied force (F) at the upper pin is 20 inches. Substituting these values of W, a and b in the formula $F = \frac{W \times b}{a}$, the force that must be applied at the upper pin by the upper rod is $F = \frac{10,000 \times 5}{20} = 2,500$ pounds.

To find the force delivered by the live lever, through the connection, to the dead lever, the middle pin becomes the fulcrum, 2,500 pounds is the applied force (F) at the upper pin, 15 inches (a) from the fulcrum, and the delivered force (W) is 5 inches (b) from the fulcrum. Therefore, $W = \frac{F \times a}{b} = \frac{2{,}500 \times 15}{5} = 7{,}500$ pounds. The correctness of this result is checked by subtracting the force, 2,500 pounds acting at the upper pin from 10,000 pounds acting at the middle pin, which must equal the force at the lower pin.

The force applied to the lower pin of the dead lever is thus found to be 7,500 pounds. In order to meet the design of truck, the dead lever is made but 16 inches long. The upper pin is the fulcrum and a force of 10,000 pounds must be delivered to the brake beam at the middle pin by means of the force of 7,500 pounds applied at the lower pin, which is 16 inches from the fulcrum; that is, $F = 7{,}500$, $W = 10{,}000$, and $a = 16$. Therefore, $b = \frac{F \times a}{W} = \frac{7{,}500 \times 16}{10{,}000} = 12$ inches. The middle pin must be 12 inches from the upper pin and four inches above the lower pin in the dead lever. It should be observed that the lower end of the dead lever is, in the case under consideration, one-third the length of the upper end, just as is the case with the live lever; and it is a very important fact to remember that, in order to obtain the same brake-shoe pressure upon each pair of wheels of the truck, the dead lever must always be proportioned precisely the same as the live lever, though its length may be different. Conversely, if the live and dead levers are proportioned alike, the brake-shoe pressure is the same upon both pairs of wheels.

As the trucks are alike, the above calculations apply to each, and it is now only necessary to remember that 2,500 pounds must be applied at the upper pin of the live lever of each truck. The top rods should be nearly parallel with the center line of the car when the cylinder and floating levers are at right angles to them, so that a force of 2,500 pounds must be delivered at the pins connecting the upper rods with the cylinder and floating lever. Let us assume that the positions of truss rods, etc., make it most convenient to so locate the brake cylinder that the length of the cylinder lever becomes $27\frac{1}{2}$ inches. The cylinder being 8 inches in diameter, the emergency air pressure upon the piston is 3,000 pounds, which is the force (F) applied at the pin at one end of the cylinder lever, while the delivered force (W) at the pin at the other end must be 2,500 pounds, the middle pin being the fulcrum, and the length (l) of the lever is $27\frac{1}{2}$ inches. Neither a nor b is known; but, from the formula for such a case, $a = \frac{W \times l}{F + W} = \frac{2{,}500 \times 27.5}{3{,}000 + 2{,}500} = 12.5$ inches. Similarly, $b = \frac{F \times l}{F + W} = \frac{3{,}000 \times 27.5}{3{,}000 + 2{,}500} = 15$ inches. The check upon these calculations is that the sum of a and b (12.5 and 15) equals l, or $27\frac{1}{2}$ inches.

To find the force delivered by the push-rod lever to the tie rod, and thereby to the cylinder lever, the top-rod pin becomes the fulcrum, $a = 27\frac{1}{2}$ inches, $b = 15$ inches and $F = 3{,}000$ pounds. Therefore, $W = \frac{3{,}000 \times 27\frac{1}{2}}{15} = 5{,}500$ pounds, which checks, as the sum of 3,000 and 2,500.

The tie rod between the push-rod and cylinder levers should be as nearly parallel with the center line

of the car as possible. It remains to determine the position of the middle pin of the cylinder lever. The force (F) applied at the middle pin is 5,500 pounds, and the force (W) that must be delivered at the top-rod pin is 2,500 pounds. We do not know distance a; but we assume that the design of the truck determines that b is 22 inches. Making $b = 22$ in the formulæ for this case, $a = \frac{W \times b}{F} = \frac{2{,}500 \times 22}{5{,}500} = 10$ inches, and $d = \frac{W \times a}{F - W} = \frac{2{,}500 \times 10}{5{,}500 - 2{,}500} = 12$ inches. These results check properly, as $22 - 10 = 12$. The middle pin must, therefore, be located 10 inches from the cylinder pin.

It will be observed here, also, that the short end of the cylinder lever is five-sixths of the length of the long end, the same as with the push-rod lever; and it is invariably necessary, in order that the same force shall be delivered to both top rods, that the push-rod and cylinder levers shall be proportioned exactly alike, though their lengths may be quite different. Conversely, also, if the push-rod and cylinder levers are proportioned alike, the same force is exerted upon both top rods.

This completes the calculations for the entire brake gear, from the brake cylinder to each brake beam, and the example has included every kind of brake-lever computation that can arise in determining the proportions of straight brake levers.

If the same car were already equipped with the air brake and it be desired to ascertain the braking power, we should pursue the reverse course. Starting with the known emergency piston pressure of 3,000 pounds as the applied force (F) at the end pin of the

push-rod lever, the middle pin is the fulcrum, $a = 12\frac{1}{2}$ and $b = 15$. Therefore, $W = \frac{F \times a}{b} = \frac{3{,}000 \times 12\frac{1}{2}}{15} =$ 2,500 pounds, delivered to the top rod.

Since the cylinder lever is found to have the same proportions as the push-rod lever, we know, without further calculation, that a force of 2,500 pounds is also delivered by the cylinder lever to the other top rod. If the cylinder lever were found to be of materially different proportions from those of the push-rod lever, we should first find the force delivered at the middle pin of the push-rod lever, by considering the top-rod pin as the fulcrum, checking the result by adding the forces at the end pins. Then, with this force as the applied force at the middle pin of the cylinder lever, we should find the force delivered to its top rod by the cylinder lever. It would then be necessary to continue the calculations through to the brake beams of the truck at the end of the car. As it is, knowing that 2,500 pounds is the force (F) applied to the upper pin of each live truck lever, we have only to trace the forces through one truck.

The applied force (F) at the upper pin of the live truck lever is 2,500 pounds and the lower pin is the fulcrum, so that, in determining the force (W) delivered to the brake beam, $a = 20$ and $b = 5$. Therefore, $W = \frac{F \times a}{b} = \frac{2{,}500 \times 20}{5} = 10{,}000$ pounds, which is the force applied to the brake beam.

As the dead lever is proportioned exactly like the live lever, we know, without further calculation, that the same force—10,000 pounds—is applied to each brake beam, and the total braking power of the car is $10{,}000 \times 4$, or 40,000 pounds, which, divided by the

weight of the car (40,000 pounds), is 1—the per cent. braking power is therefore 100.

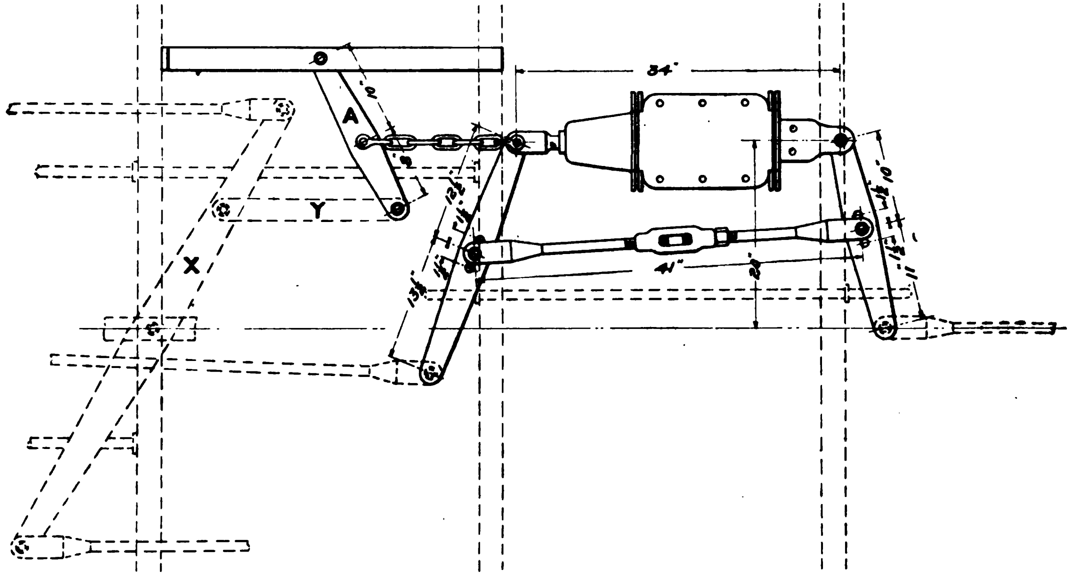
If the dead lever were proportioned materially different from the live lever, it would be necessary to regard the middle pin of the live lever as the fulcrum and to first find the force delivered at the lower pin, checking the result by subtracting the force at the upper from that at the middle pin, which remainder it must equal. With this force applied at the lower pin of the dead lever, and with the upper pin as the fulcrum, we should then find the force delivered to the brake beam at the middle pin. The sum of the forces found to be applied to the four different brake beams would then be the braking power upon the car.

The forces above calculated, and shown upon the diagram of Fig. 2 represent an emergency application and are designated by the letter E. In a full service application, the air pressure upon the piston of the 8-inch brake cylinder is but 2,500 pounds, and the forces thereby developed throughout the brake gear are designated upon the same diagram by the letter S. The calculation of these forces is left as an exercise for the interested reader.

The foregoing example illustrates the method of calculating the braking power developed by any system of straight levers employed in car brakes. If the brake gear includes other levers in addition to those of the example illustrated on Plate 47, the same methods and formulæ are applicable in the extended calculations.

Reference to Fig. 3, will show that the push-rod lever is made somewhat longer than the cylinder lever so that the top rod from the former will clear

FIGURE 3.



STANDARD SET OF BODY LEVERS.

the fulcrum of the hand brake lever, which should be placed on the center line of the car. With our standard set of body levers (Fig. 3), we supply a multiplying lever A, by which a pull of 1,665 pounds in rod B gives a force of 3,000 pounds at the brake-cylinder push-rod pin, and it then remains to so proportion the hand-brake lever X that a pull of 1,000 pounds on the hand brake rod will give the required pull on the rod B.

Assuming that the design of the car necessitates the lever X (Fig. 2) being 20 inches long on each side of the center line of the car, we can take the applied force F = 1000 pounds, to be exerted at the hand-brake-rod pin, and the delivered force W = 1665 pounds, at some point between that pin and the fulcrum in the center. (See Fig. 1.) We do not know b, but $a = 20$ in. Therefore, $b = \frac{F \times a}{W} = \frac{1{,}000 \times 20}{1{,}665} = 12.012$ inches, or say 12 inches. Consequently, the pin for rod B must be 12 inches from the fulcrum, or 8 inches from the hand-brake-rod pin. It will be noted that, as lever X is the same length on each side of the fulcrum, the pressure delivered to rod B is just the same when the force is applied at either hand-brake staff, because in both cases $a = 20$ and $b = 12$, and the applied force is identical.

Sometimes the size and arrangement of motors make it advisable to divide the truck levers and bottom rod into two of each, one set on each side of the motors. In this case, the two live truck levers are connected by a short rod to each end of a "radius" bar which, in turn, is connected through a roller in the end of the top rod from the push-rod or cylinder levers so as

to allow the trucks to accommodate themselves to curves of a very small radius. Normally the roller stands at the middle point of the radius bar, and thus the pressure transmitted by the top rod is divided into two equal parts, each live truck lever receiving one of them. Consequently the above methods of calculating the levers will hold equally good in this case, the amount of pressure to be transmitted by the top rod in both cases being exactly the same.

In figuring the braking power of a car so equipped, the above method may be followed throughout if the truck levers on each side are exactly alike, the result being the same whether the braking pressure be figurd per axle, or per wheel. If the truck levers are not alike, it will be necessary to divide the top rod stress into two parts, and follow out each part on its side of the truck.

The following table gives the forces exerted upon the pistons of the different sized cylinders with pressures of 50 and 60 pounds to the square inch:

Size of Cylinder,	16″	14″	12″	10″	8″	6″
50 pounds pressure,	10050	7700	5650	4000	2500	1400
60 pounds pressure,	12050	9200	6700	4700	3000	1700

Auxiliary Reservoirs Used With Different Sizes of Brake Cylinders.

10″ x 33″	Auxiliary	Reservoirs	with	8″	Brake	Cylinders	of	all	kinds;
12″ x 33″	"	"	"	10″	"	"	"	"	"
14″ x 33″	"	"	"	12″	"	"	"	"	"
16″ x 33″	"	"	"	14″	"	"	"	"	"
16″ x 42″	"	"	"	16″	"	"	"	"	"

Foundation Brake Gear.

Wherever possible, the brake beams should be so hung that, whether the car be light or loaded, they shall always be at the same distance above the rail. This practice greatly reduces the liability of flat wheels, since the piston travel is not affected by the loading or unloading of the car and may, therefore, be properly adjusted whether the car be light or loaded.

It is always best to so design the hand and air brakes that they shall "work together"; that is, so that all the levers move in the same direction when the brakes are applied by hand as when applied by air. Where they "work opposite," or where hand power pulls against air power, only one can be successfully used at a time, which is very inconvenient where the air brake is applied upon cars that are to stand for some time on a grade, since the hand brakes cannot be applied until the air brakes have been released. Many other objections to such an arrangement occur in road practice, and brakes that "work together" are much to be preferred, from the standpoints of both practicability and safety.

In securing brake cylinders to car bodies, an iron plate is much to be preferred to wooden blocks, since the latter shrink, thus loosening the bolts and permitting movement of the cylinder every time the brakes are applied. This movement of the cylinder is imparted to the train pipe and is a very productive source of leaks.

Triple valves should be so located as to be easy of access for cleaning or repairing.

Levers should stand approximately at right angles to the rods when the brakes are applied.

It is important that the rods should be as nearly as

possible parallel with a longitudinal line through the center of the car when the brakes are applied.

The following percentages of their light weights are the usual braking powers for the different vehicles of trains:

Motor-cars,	100% on axles having motors attached to them.
	90% on free axles.
Trailer-cars,	90%.
Freight Cars,	70%.

Slight modifications of this general practice are sometimes desirable, to meet special conditions.

The following table shows the proper sizes of cylinders to be used with cars of different weights, on a basis of 90 and 100 per cent. braking power:

Cylinder for Car.	Light Weight of Car. 90%	100%	
6″	Up to 22,700	Up to 20,000	pounds
8″	22,700 to 40,000	20,000 to 36,000	"
10″	40,000 to 58,000	36,000 to 52,000	"
12″	58,000 to 80,000	52,000 to 72,000	"
14″	Above 80,000	Above 72,000	"

Fig. 3, page 13, illustrate the design of our Standard Sets of Body Levers such as we recommend and furnish in all cases, unless otherwise specified, or the design of the car is so unusual as to compel a modification of them. It will be noted that both the push-rod and cylinder levers have three points at which the tie rod may be connected; the outside holes indicate the maximum and minimum leaverage, and consequently braking powers, that may be obtained with the cylinder for which the levers were designed. The table opposite gives the important dimensions of the rods and levers in each set as designated by the size of cylinders in the equipment.

Dimensions of Standard Body Levers.

Diam. of Cylinder	Maximum Total Leverage Ratio	Length of Levers		Section of Levers at Center
		Push Rod	Cylinder	
6″	12 to 1	26″	21″	3″ x ¾″
8″	12 to 1	26″	21″	3⅛″ x 1″
10″	11 to 1	28″	28″	4″ x 1″
12″	10¾ to 1	31½″	31½″	5″ x 1″
14″	10 to 1	35″	35″	6″ x 1″

Diam. of Cylinder	Distance from Push Rod to Tie Rod				Diam. of Solid Tie Rod for Maximum Load
	Maximum		Minimum		
	Push Rod Lever	Cylinder Lever	Push Rod Lever	Cylinder Lever	
6″	12½″	10″	7″	5⅝″	¾″
8″	12½″	10″	8″	6½″	⅞″
10″	12¾″	12¾″	8″	8″	1″
12″	14⅛″	14⅛″	9″	9″	1⅛″
14″	15″	15″	10″	10″	1¼″

Westinghouse Traction Brake Company

General Sales Office

26 Cortlandt Street, New York, U. S. A.

Cable Address

"Airbrake, New York"

Telephone, 6950 Cortlandt

Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F. No. 026

January, 1904

Instruction Pamphlet No. T 5024

A Chapter of "Don'ts"

WESTINGHOUSE TRACTION BRAKE CO.,
26 Cortlandt Street,
New York, U. S. A.

A Chapter of Don'ts.

Don't work motor-driven compressors more than 50 per cent. of each hour; if proper size has been chosen, with the apparatus and piping in good condition, a compressor in brake service should not operate more than 30 per cent. of the time, even in city service.

Don't let the equipment run with the governor out of order, trusting to the motorman to start and stop the compressor when necessary.

Don't work motor-driven compressors against a pressure of more than 100 pounds.

Don't run a 600-volt compressor on a line having more than 650 volts.

Don't connect armature lead to trolley, and field lead to ground; this is the reverse of what it should be.

Don't run the compressor without a proper size fuse in its circuit. See table in Instruction Pamphlet No. T. 5002.

Don't plug the vent pipe.

Don't leave the motor door open.

Don't forget to oil the compressor regularly.

Don't neglect to keep the commutator clean and the brushes free in their holders.

Don't permit the suction screen to clog up with dirt.

Don't allow the brake rigging to become so slack and the shoes so worn that the travel of the brake cylinder piston will exceed 8 inches; otherwise the air brake will not be effective.

Don't keep the car in service if there are any bad leaks in the piping. Such a conditon compels the compressor to be in constant operation.

Don't allow the motormen to "fan" the air brake handle; such a manner of operating wastes air, makes uneven stops and causes much unnecessary wear and tear to the apparatus.

Don't fail to see that the bolts and nuts are tight. These can be looked at when the motor is being inspected.

Don't imagine the air brake can last indefinitely without lubrication. In this respect it is no different from other machinery.

Traction
npany

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"
Telephone, 6950 Cortlandt
Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P. F No. .027